SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

APRIL 1901.

GENERAL PHYSICS.

597. *New Method for Vortex Rings.* **P. Czermak.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 878–890, June and July, 1900.)—The method here described for producing vortex rings in the air consists in striking the elastic back of a Tait's chamber by a bent lever, actuated by a weight falling through a given height, which may be varied at will. In order to detect the rings without their being coloured by smoke, they were shot against a blackboard dusted over with lycopodium. E. H. B.

598. *Specific Gravities of the Halogens and of Oxygen and Nitrogen at their Boiling-points.* **J. Drugman** and **W. Ramsay.** (Chem. Soc., Journ. 77. and 78. pp. 1228–1233, Nov., 1900.)—To determine the specific gravities of liquid iodine at its boiling-point the authors employ a small glass bulb with a capillary tube bent twice at right angles. After measuring the capacity of the bulb, the latter is filled with the liquid, heated in a wide tube containing the boiling liquid until it assumes the temperature of the surrounding vapour and then allowed to cool, when the weight of the contained halogen is determined. In the case of chlorine and oxygen a thermometer bulb was made use of, the stem being bent as before, whilst with nitrogen the vapour-jacket was dispensed with. It has been stated by Moissan and Dewar that, at —190°, amber agrees almost exactly in density with liquid fluorine. The specific gravity of the latter is hence approximately measured by the authors by comparing the specific gravity of amber with that of liquid oxygen, the boiling-point of which is slightly higher than that of fluorine. The following table gives the mean specific gravities of the various liquids at their boiling-points under atmospheric pressure (760 mm.) :—

Iodine..............	3·706	Oxygen..............	1·1316
Chlorine...........	1·5071	Nitrogen	0·7914
Fluorine...........	1·108 (about)		

The value for nitrogen is much lower than those given by Wroblewski (0·83 under 1 atmosphere) and by Olszewski (0·886 under 748 mm. and 0·859 under 740·9 mm. pressure).

The above results, together with others previously determined, lead to the following specific and molecular volumes :—

	Specific volume.	Molecular volume.
Nitrogen	1·390	39·04
Phosphorus	0·6734	41·82
Oxygen	0·8838	28·28
Sulphur	0·6757	43·20
Fluorine	0·9025	34·30
Chlorine	0·6635	47·04
Bromine	0·3392	54·26
Iodine	0·2698	68·46

T. H. P.

599. *Solar Radiation*. (Brit. Assoc. Report, 1900, pp. 36–45.)—This report of the British Association Committee describes the work of the year both in actual observations of solar radiation and in the improvements effected in the instruments used. It is found preferable to employ Callendar's automatic recording instrument for direct exposure to sunshine and to calibrate the receivers in absolute measure by other experiments. As much as 40 per cent. of the whole vertical component of radiation is sometimes found to come by reflection from the sky. E. H. B.

600. *Graphometer*. **V. Hensen.** (Zeitschr. Instrumentenk. 20. pp. 357–360, Dec., 1900.)—This is an instrument for graphical interpolation and curve measurements, a complement to Amsler's polar planimeter. Two advantages are claimed. Distances are marked by needle-pricks and measured on the needles; and two milled wheels are applied which always tend to keep parallel to one another. It is constructed by Zwickert, of Kiel. H. B.

601. *Rain Formation*. **H. Mache.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 793–798, June and July, 1900.)—In the neighbourhood of a drop of water of radius r, the vapour pressure p is increased, by surface tension, by $\Delta p = 2\omega a / (w - \omega)r$, where a is the capillary constant and w and ω are the specific volumes of the steam and the water. In air supersaturated with vapour, there will be a critical radius ρ for which the capillary and the saturation pressures will balance one another. Drops of larger radius will grow by condensation, and of smaller radius will evaporate, the latter the more rapidly per surface unit the smaller the radius. Hence only water-drops of a radius greater than ρ can serve for condensation nuclei in a supersaturated atmosphere. A rain-cloud may be likened to a layer of air, supersaturated with moisture by a fall in the temperature, containing condensation nuclei which will grow until they have passed by gravity out of that layer. On their further descent their radii will not change much. The author calculates that there should be far more large than small drops. C. T. R. Wilson has assigned to his nuclei a radius ρ of 10^{-7} cm. The author thinks that, for rain-formation, the ρ must be greater and lie between $1{\cdot}2 . 10^{-4}$ and $2{\cdot}4 . 10^{-5}$; for an extreme case of supersaturation, caused by a sudden temperature fall from 20 C. down to 0° C., the ρ would only be $8{\cdot}7 . 10^{-6}$. It would therefore appear that the condensation nuclei must be dust particles, and not molecular aggregates of the highest orders. H. B.

602. *Fog Studies on Mount Tamalpais.* **A. G. McAdie.** (Monthly Weather Rev. 28. pp. 492–493, Nov., 1900.)—Further remarks on fogs near San Francisco and the remarkable topography of the district [see Abstract No. 2389 (1900)]. A kite meteorograph has frequently been attached to the top of a car of the train which descends the 8 miles from the observatory, at an elevation of 724 m., down to sea-level in 50 minutes, cutting through the fog. The afternoon fogs of the Bay seem to be due to mixtures of air masses (von Bezold) rather than to radiation and expansion, whilst the winter fogs of the Sacramento and San Joaquin valleys are apparently pure types of radiation fogs, the process of cloud-building going on from the cooled ground upward. One of the four photographic plates shows very well the air-waves (Helmholtz) of fog-clouds and their surgings and splashings. H. B.

603. *Sea-Waves of the Japanese Earthquake of June* 15, 1896. **C. Davison.** (Phil. Mag. 50. pp. 579–584, Dec., 1900.)—The epicentre was situated east of Kamaishi (which was destroyed by the sea-waves), at a depth of 4,000 fathoms near the foot of the western slope of the Tuscaroora Deep; the time was 10h. 31mins. a.m. G.M.T., and only two self-recording tide gauges mark the sea-waves, those at Honolulu and at Sausalito (entrance of San Francisco Bay); the latter was then the only automatic gauge in operation on the Pacific coast of the United States. The records are reproduced in this paper. There are no islands at all along the great circle, joining the epicentre to Sausalito; the mean ocean depth along that line is 17,000 feet, while the formula $\sqrt{gH} = V$ (in which H is the uniform ocean depth in which waves would travel with the same mean velocity V as that of the seismic sea-waves) yields 13,778 feet, *i.e.*, about $\frac{4}{5}$ of the measured value. The author had previously shown that the calculated values should be considerably less than the true mean depth. From the Honolulu records a mean depth of 14,492 would result. The epicentre line follows the long chain of islands of which the Hawaiian Islands form the eastern end. The mean depth on that great circle is 13,500 feet; if the earliest waves that reached Honolulu deviated a little from that line, however, they would pass through much deeper water. H. B.

604. *West Indian Hurricanes.* **E. B. Garriott.** (U.S. Weather Bureau, Bull. H. 232. pp. 3–69, 1900.)—The author reviews papers on this subject, beginning with W. C. Redfield (1821) and W. Reid, and dealing very fully with Benito Viñez, of Havana. The magnitude and force of a hurricane is, in the opinion of the latter, always proportional to the magnitude and perfection of the precursory cirri, and their divergence focus shows the bearing of the vortex. E. del Monte and Halkzenbrich, also of Havana, confirm these views. Lists of hurricanes are given, reproducing those of A. Poëy (enumerating 355 storms between 1493 and 1855) and of others, and descriptions of notable hurricanes, partly in monthly arrangement. Out of the 95 West Indian hurricanes traced during the last twenty-three years, 76 had a recurve to the northward; during the principal months, August to October inclusive, the hurricanes generally recurved east of the Gulf of Mexico, and their mean tracks shifted further west as the season advanced. Yet the charts show that hurricanes may spring up during these months in any part of the region between the 13th and 25th parallel, east of the 80° meridian. The theory is hardly touched upon. H. B.

605. *Daily Temperature Variations in Lake Wolfgang.* **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 905–922, June and July, 1900.)—A preliminary account is given of observations made during the summer and autumn of 1899 in Lake Wolfgang, Salzburg, at a spot 15 m. from the bank, in water having a depth of 9 m. Bolometers were used with thin platinum wires connected by constantan wires with a Wheatstone bridge; the wires were well covered with rubber bands and tubing; temperatures could be determined within 0·03° C. Five bolometers were arranged in a vertical line at depths of 24, 87, 149, 274, and 524 cm. It was ascertained that the direct sun rays did not raise the bolometers to a higher temperature than the surrounding water; the wire connections in the air did not cause any trouble. It further resulted that it did not matter whether psychrometer tests were conducted on the lake or on the land. The paper tabulates the uninterrupted observations from August 29th to October 3rd. The water temperature curves are, of course, much smoother than the air temperature curves, but they show the chief variations. The afternoon maximum of the water coincides with the air maximum. Conduction, therefore, plays no part —convection could be evident in the case of cooling only—and hence the lower water strata appear to be essentially heated by radiation. The temperature variations decrease very rapidly with increasing depths, but the radiation was still noticeable at a depth of 5·2 m. H. B.

606. *Barometric Variation with Synodic Revolution.* **A. Poincaré.** (Comptes Rendus, 131. pp. 1262–1264, Dec. 24, 1900.)—This paper gives the results of a further investigation than that mentioned in Abstract No. 617 (1900). Tables are given showing the differences from the mean variation in two regions, one in the temperate zone about 40° lat., the other polar. The effects in the polar region are the reverse of those produced in the temperate locality. Generally in the temperate region the difference between the extreme values attains a *minimum before* the *first quarter* and *after the second*, &c. C. P. B.

607. *Variation of Latitude.* **J. K. Rees.** (Amer. Phys. Soc., Bull. 1. pp. 34–36, 1900.)—This paper gives the results obtained at the Columbia University from May 1, 1893, to July 1, 1894. The observations are divided into four series, and the variations found are given in tabular form. The value of the "*constant of aberration*" determined was 20·464″ ± 0·006.″

C. P. B.

REFERENCES.

608. *Apparatus for Impact Tests of Materials in Tension.* **W. K. Hatt** and **W. P. Turner.** (Railroad Gazette, 32. pp. 766–767, Nov. 23, 1900. Extracts from a paper read before the Paris International Congress for the Unification of Tests of Materials.)—This describes a permanent apparatus constructed in place of a temporary apparatus built of wood [see Abstract No. 1236 (1900)] for testing the behaviour of iron and steel under impact in tension. The permanent apparatus is similar to the temporary one in principle but is constructed of iron, and arranged so as to make the testing of samples able to be done more quickly than with the original form. E. C. R.

609. *Stationary Radiants of Shooting Stars.* **T. Brédikhine.** (Acad. Sci. St. Pétersbourg, Bull. 12. pp. 95–120, 1900.)—This paper, being an analytical one, is unsuitable for condensation; it gives a full discussion of the various examples cited for explaining the phenomenon, and a most useful series of references to existing literature on the question. C. P. B.

LIGHT.

610. *Application of Fourier's Double Integrals to Optical Problems.* **C. Godfrey.** (Roy. Soc., Phil. Trans. 195. pp. 329–362, Dec. 24, 1900.)—Gouy has pointed out in a passage quoted by the author that ordinary light does not consist of an infinite series of regular undulations, such as originally treated of in the undulatory theory, and Gouy suggests the analysis of disturbances by Fourier's theorem as a means of adapting the theory to the explanation of actual phenomena. This is the method followed in the present treatise. The writer deals in this place solely with plane and plane-polarised light.

The fundamental theorem is one due to Rayleigh and Schuster, namely, that if—

$$f(t)=\int_0^\infty R_1 \cos(ut+\psi_1)du$$

$$\phi(t)=\int_0^\infty R_2 \cos(ut+\psi_2)du$$

where R_1, R_2, ψ_1, ψ_2 are functions of u, then—

$$\int_{-\infty}^{\infty} f(t)\phi(t)dt=\pi\int_0^\infty R_1R_2\cos(\psi_1-\psi_2)du,$$

and therefore if $f(t)$ and $\phi(t)$ denote the same function—

$$\int_{-\infty}^{\infty} \{f(t)\}^2 dt=\pi\int_0^\infty R^2 du,$$

It follows that in integrating the energy of a system of waves over any time (and such integrated energy is what we directly observe) differences of phase disappear, and the result depends only on the distribution of energy among the different elements of the Fourier integral. This result is applied to (1) Interference; (2) The influence of light on a vibrator.

The author next considers radiation composed of a random aggregate of pulses with reference to the papers of Lommel (Wied. Ann. 3. 251, 1878) and Rayleigh (Phil. Mag. 27, 1889), and to J. J. Thomson's explanation of the phenomena of the Röntgen rays as arising from a series of electric pulses.

Thomson's theory on this subject is separately discussed in sections 31, 36, and compared with Stokes's explanation of the same phenomena.

The author then proceeds to the radiation of an incandescent gas. The molecules are supposed, according to the usual theory, to spend their time between relatively long "free paths," and relatively—in this treatise infinitesimally—short periods of time during which they are in encounter with other molecules. By such an encounter this molecule is set vibrating and continues during its free path to send out trains of waves which represent the effect on ether of such vibration. Such a train of waves has therefore a definite beginning and a definite end, and may be represented by the appropriate Fourier series. The radiation observed will thus consist of a great number of finite trains superposed. But as the velocities of the molecules are comparable with that of radiation, the apparent frequency will depend in some degree on the velocity of the molecule and the angle which its direction makes with the line of sight. These trains are analysed by Fourier's theorem. The effects are summed up for all molecules having definite velocities, both athwart and in the line of sight, Tait's results obtained for elastic spheres being employed for this purpose.

The writer then considers the Visibility Curve, discussing Michelson's papers (Phil. Mag. 31 and 34). The case of zero pressure is considered by the help of Tait's tables (Edinbro Phil. Trans., vol. 33).

The writer treats of the effect of Damping on the width of spectrum lines, obtaining the result, which Lommel had given after a less complete analysis, that the spectrum lines are widened through damping.

Next is discussed the character of the ether motions in nearly homogeneous light. The view that the possibility of producing a large number of interference fringes from white light indicated a certain regularity in the ether motions has been, the writer says, refuted by Gouy, Rayleigh, and Schuster. This question is discussed by means of Fourier's integrals.

The paper ends with a discussion on the effect of natural light on a vibrator. The equation of motion of the vibrator is taken to be—

$$\ddot{x} + 2\kappa\dot{x} + p^2x = f(t) = \int_0^\infty \mathrm{R}\cos(ut + \psi)du.$$

But this is given as a hypothesis only, assuming that a molecule can be regarded as a simple vibrator. The writer considers in this relation Sellmeier's treatment of the subject of dispersion, pointing out an error into which Sellmeier has fallen that the natural vibration of a molecule under the influence of constant light will be insignificant compared with the forced vibration. The result here obtained is that, so far as the theory of the vibration carries us, the natural vibration may be as prominent as the forced vibration. [See also Abstract No. 820 (1900).] S. H. B.

611. *Reflection of Light in the Neighbourhood of the Critical Angle.* **J. G. Coffin.** (Technology Quarterly, 13. pp. 139–144, 1900.)—This paper gives the results of a calculation of the percentage of light reflected on passing from a dense to a rare medium at various angles of incidence from 0° up to the critical angle. It is noteworthy that the proportion of reflected light increases but very slowly as the angle of incidence increases until within about 10° of the critical value, when there is a sudden and marked increase. The results are shown on a curve in which the ordinates represent the percentage of reflected light and the abscissæ the angles of incidence. The index of refraction is taken as 1·5. The tangent to the curve near the critical angle is nearly perpendicular to the axis of abscissæ. A change of less than 1° in the angle of incidence near this point increases by 50 per cent. the amount of reflected light. J. J. S.

612. *Refraction of Hydrocarbons with Condensed Benzene Nuclei.* **A. Chilesotti.** (N. Cimento, 12. pp. 290–293, Nov.–Dec., 1900. From the Gazz. Chim. Ital. t. 30. I, 1900.)—Results are given of the measurements of the refractions of dibenzyl, stilbene, tolane, phenanthrene, retene, and fluorene in benzene solution, and of anthracene in naphthalene solution, the influence of the solvent on the refraction being allowed for by means of Landolt's formula for mixtures. In the following table the mean experimental numbers are given for the line H_α according to both the Gladstone and the Lorenz and Lorentz formulæ, and for the specific dispersion (H_A) according to the Gladstone expression; the values calculated from the structural formulæ are also given, the atomic refractions used being as follows: For the Gladstone formula—carbon 5, hydrogen 1·30 and a double linking 2·40; for the Lorenz and Lorentz formula—carbon 2·48, hydrogen 1·04 and a double bond 1·78.

	$M(\mu_{H_\alpha}-1)/d.$			$M(\mu_{H_A}-1)/d.$			$M(\mu^2_{H_\alpha}-1)/(\mu^2_{H_\alpha}+2)d.$		
	Found.	Calc.	Diff.	Found.	Calc.	Diff.	Found.	Calc.	Diff.
Dibenzyl	103·83	102·60	1·23	101·55	101·50	0·05	59·59	59·96	0·37
Stilbene	115·43	102·40	13·03	113·39	101·00	12·39	65·44	59·66	5·78
Tolane	111·70	99·64	12·06	—	—	—	62·07	58·02	4·05
Anthracene ...	109·34	97·40	11·94	100·3	—	—	61·15	55·80	5·35
Phenanthrene..	110·70	99·80	10·9	108·31	98·4	9·91	61·59	57·58	4·01
Retene	145·12	130·2	14·92	—	—	—	80·64	75·82	4·82
Fluorene	98·30	92·40	5·90	97·49	91·20	6·29	55·28	53·32	1·96

From these numbers it is seen that of the compounds given, dibenzyl is the only one which obeys the laws of Landolt and Brühl. The values in the above table differ somewhat from those obtained by Gladstone in 1870, the greatest deviation being in the case of anthracene, for which Gladstone found the molecular refraction 100·3.

Taking the centric formula for the benzene nucleus, the refractive value of each centric linking is for naphthalene, anthracene, phenanthrene, and pyrene, 1·39, 1·46, 1·54, and 1·48 respectively, the Gladstone molecular refraction formula being used; with the Lorenz and Lorentz formula the value is even more constant, the numbers for each centric linking being for benzene 0·89, naphthalene 0·90, anthracene 0·89, and phenanthrene 0·90. Hence centric structural formulæ for aromatic hydrocarbons accord best with their optical properties. T. H. P.

613. *Refraction by Ethyl-Ether near its Critical Point.* **B. Galitzine** and **J. Wilip.** (Acad. Sci. St. Pétersbourg, Bull. 11. pp. 117–196, Oct., 1899.)—An account is given of experiments conducted with the object of measuring directly the indices of refraction of ethyl-ether and its saturated vapour for temperatures in the neighbourhood of the critical temperature. Two methods were employed. In one (see Acad. Sci. St. Pétersbourg, Bull. 3. p. 131, 1895) the tube containing the substance under investigation was employed as a cylindrical lens; silver was deposited on the back of the tube and two parallel lines drawn on the silver; from the observed distance between the images of these lines at any part of the tube the index of refraction of the corresponding layer of the substance in the tube was calculated. A special thermostat was employed, consisting of two semicircular vessels containing glycerine and surrounded by two similar ones in communication with a vessel containing naphthaline boiling under pressure; these vessels were fastened together, but separated by parallel plane glass panes, the tube under investigation being placed in the centre of the circular vessel so formed, and air being excluded above and below by packing with cotton-wool; any temperature between 180° and 200° C. could thus be maintained with variations hardly exceeding 0·05° C. Stirrers were placed both in the

thermostat and in the tube. Monochromatic light corresponding to the red lithium line was used. The constants of the instrument were determined by observations on substances of known refractive index. Series of experiments were conducted with ordinary and specially prepared glass tubes and with and without the stirrer in the tube being used. Errors in the calculated refractive index were estimated to be of the order 0·005 owing to the uncertainties in the constants of the apparatus, and of the order 0·001 owing to errors of observation. The observations show that with a good thermostat and thorough mixing of the different layers in the tube the critical temperature may be determined by this method, with a possible error between 0·1° and 0·2° C. It is also found that in an interval of temperature from a little below the critical point (the fluid being compressed) to about 4° C. above the critical temperature the index of refraction is completely independent of the temperature and a function of the total volume only. Lorentz's formula, $\frac{x^2-1}{x^2+2}v=\mathrm{C}$, connecting the index of refraction x, and the density of the substance $\left(\delta=\frac{1}{v}\right)$ is verified for a wide range of temperature, and the value $\mathrm{C}=0{\cdot}3025$ determined from a large number of observations. When the stirrer in the tube is not used, the index of refraction is found greater in the lower layers both for the liquid and vapour and for temperatures below and above the critical temperature. The differences are large and beyond the limits of error, and therefore the ordinary methods for the determination of the critical constants of substances depending on the vanishing of the meniscus between the liquid and its vapour are only accurate when thorough mixing of the different layers is ensured. Also observations of a sudden great change of refractive index at places where the meniscus has vanished on passage through the critical point seem to show that the fluid phase persists above the critical temperature, and that a delay in evaporisation occurs. Three hypotheses as to the cause of the observed differences of density are discussed and found to be unsatisfactory, viz., that they are due (1) to inequality of temperature; (2) to gravity; and (3) that the differences in the values of the refractive index arise from traces of air being present.

In the second method a thin prism was placed in the tube containing the ether with its edge parallel to the wall of the tube, and the deviation occurring in a horizontal beam of light, after passing through any layer of the substance in the tube, was measured, and the corresponding refractive index was thence calculated. The method was found not to afford the same degree of accuracy as the first method, but the conclusions drawn from the previous observations were confirmed. W. E. T.

614. *Goniometer.* **J. Domke.** (Zeitschr. Instrumentenk. 20. pp. 360–362, Dec., 1900.)—This is a simple mirror instrument, known as pantogon and constructed by G. Meissner, of Berlin, for measuring angles up to 300° within one minute of arc without the use of a telescope. Both metallic mirrors are perpendicular; the movable one has a line at the level of the upper ridge of the fixed mirror. The instrument can also be applied for the survey of coasts and for determining on board ship the height of a promontory. H. B.

615. *Stereoscopic Röntgen Ray Apparatus.* **H. Boas.** (Deutsch. Phys. Gesell., Verh. 2. 4. pp. 45–52, 1900.)—The author describes apparatus for casting images upon a screen from two points of view alternately, and glimpsing at them with the two eyes alternately through a binocular strobo-

scopic apparatus containing a revolving arrangement acting in synchronism with the alternations on the screen. Two distinct spark-inductors are used and alternately actuated by a turbine interrupter. A. D.

616. *Phosphorescence.* **G. le Bon.** (Revue Scientif. 14. pp. 289–305, Sept. 8; 327–341, Sept. 15, 1900.)—Phosphorescence due to the impact of ordinary light is familiar: that due to the action of infra-red rays or of heat may be readily studied by means of a lantern projection lamp darkened completely, with a biscuit-tin lid at the top; this lid is placed at about 65° when one wick is lit, 130° when two, and 225° when three are lit. If a slip of ebonite 0·5 mm. thick be slipped into the grooves, and held in place by two slips of glass, much infra-red radiation passes through, of wave-length 0·8 to 2μ, this being the infra-red radiation which can set up phosphorescence. The metal chimney sends out waves of from 5 to 6μ; but these do not produce phosphorescence. The observer must have been at least fifteen minutes in complete darkness, and must not himself see any light used to excite phosphorescence. Most bodies, under the action of light and some other causes, emit effluvia capable of rendering air conductive and of traversing material obstacles such as a sheet of metal, and of the same nature as those emitted by radio-active bodies. Phosphorescent bodies in nature—diamond (usually), apatite, fluorspar, leucophane, &c.—phosphoresce feebly; artificial ones—sulphides of alkaline earths, &c.—much more strongly. Evanescently phosphorescent bodies include fluorescent bodies; there is no real distinction; the rays which produce the effect extend from the blue to far into the ultra-violet. Sulphide of calcium begins to phosphoresce distinctly but faintly after $\frac{1}{30}$ second exposure to the sun; barium sulphide after a longer time; strontium sulphide after several seconds. Sulphide of zinc with *green* fluorescence—the stock of which has been used up and which the chemical works have not been able to reproduce, but of which Le Bon has some screens which he offers to physicists—has peculiar properties; when it is made to phosphoresce by sunlight the phosphorescence is extinguished by yellow, green, red, and particularly by infra-red, in which the extinction is perceptible in $\frac{1}{10}$ second. Rays from a petroleum lamp put out its phosphorescence: whereas the sulphides of Ca, Ba, and Sr are excited to phosphorescence by these rays. This sulphide of zinc is a detector of infra-red rays as that of calcium is of blue and ultra-violet rays. The spectrum from blue to ultra-violet excites phosphorescence; from green down to infra-red it tends to extinguish it: in an intervening portion, about line F, it excites phosphorescence up to a certain feeble intensity, but reduces to the same intensity any existing phosphorescence. Blue and violet (G to H) are much more active than ultra-violet in producing phosphorescence. A screen of the ZnS referred to does not phosphoresce in light passed through quinine sulphate solution; if phosphorescing, it is extinguished; the other sulphides react similarly, but a feeble phosphorescence is excited or remains as the case may be, and in the latter case the extinction is not only partial but slow. But if a tank containing a saturated ammoniacal solution of sulphate of copper (2 cm. thick) be interposed between the quinine solution and the zinc sulphide screen, sunlight will make the screen phosphoresce very brightly; the extinctive part of the spectrum has been cut off and the blue rays have acted in the absence of the ultra-violet, which has been cut off by the quinine solution. A piece of blue glass is not as good an absorbent of the extinctive rays, and the corresponding phosphorescence is less bright. With a screen of green-phosphorescent ZnS, directly exposed to the sun, the phosphorescence corresponds in brightness to 0·002 that of a

candle-flame: exposed to diffused light (which is bluer than direct sunlight) the brightness is 0·004 candle-flame; to sunlight under cobalt blue glass, 0·014; to diffused light under cobalt blue glass, 0·018; to sunlight through a 2 cm. thickness of ammoniacal solution of $CuSO_4$, 0·028, fourteen times as great as in the first case. The other sulphides, being less affected by the extinctive rays, show no such marked differences. Sulphide of strontium and this particular sulphide of zinc give the same green tint; but the former is easily excited by a candle, the latter is extinguished by it.

Exposure to the sun at different temperatures.—The phosphorescence increases from 0° to 100°; beyond this it falls off and is zero at about 500°. The phosphorescence-light is then thrown off as fast as it is excited. At say —190° (liquid air) magnesium ribbon produces no phosphorescence; but on allowing the screen to assume the surrounding temperature (which is equivalent to heating it through, say 200°) phosphorescence appears. Time has much less influence than temperature in causing loss of phosphorescence: at a very low temperature the loss is exceedingly slow; at a very high temperature it is very rapid; at intermediate temperatures it is first rapid and then asymptotic, leaving a certain residual phosphorescence the amount of which depends upon the temperature that is maintained. Sulphide of calcium at ordinary temperatures is considerably above the temperature at which it begins to phosphoresce, and therefore loses brightness steadily; fluorspar and apatite do not phosphoresce below 50°, and time does not affect their phosphorescence. The temperature at which phosphorescence begins is in every case far below the temperature of incandescence, and phosphorescence is a "cold" light; but it is too weak for practical use. This weakness is not, however, the cause of the temperature being apparently low; but we do not know anything about the infra-red region of the phosphorescence spectrum; the bolometer only shows us that the maximum energy of the light (from phosphorescent animals, Langley) is in the yellow, and in any case any small rise of temperature detected may be due to a concomitant phenomenon.

Invisible phosphorescence (light too faint to be seen) may continue for (eighteen or more) months, without any heating; and the invisible rays may be refracted or polarised, and affect photographic plates. Further, the effect of exposure to light does not die out with the disappearance of invisible phosphorescence, for when even this has died out, certain dark radiations (wavelengths up to 2μ) may re-excite phosphorescence, up to the point of visibility. There is, therefore, some "residue" permanently left in the body, as the result of the momentary exposure to light; but this can be dissipated by heat, or by repeating the above experiment, say fifty times, or by protracted exposure to the dark rays. Sulphide of zinc is not sensitive to infra-red radiations in this way: its residue can only be discharged by heating to 100°. Some striking experiments may be made, setting up phosphorescence in a dark room by means of rays from a darkened lamp passed through ebonite or a thick layer of Japan varnish: sulphide of calcium works best: and the phosphorescence set up is bright enough to enable a photograph of the phosphorescent screen or statuette to be taken in forty minutes. It is the impact of the particular dark waves that produces the temporarily revivifying effect and the partial or complete exhaustion of the residue, not the heat produced on the impact of these waves. Incidentally, the "heat-waves" are not necessarily the infra-red: they may be so when the source is at a low temperature; but when the compression of the whole infra-red into a small space in the ordinary spectrum is taken into account, the maximum heating power in sunlight is found to be near line D. Most bodies are transparent to infra-red rays as detected by this test, which is more delicate than the bolometer. The infra-red rays also destroy chlorophyll, prevent the formation of sugar in plants, and have a reversing action in photography. In wearing out the phosphorescence of a sunned screen, infra-red rays act more promptly than heat: they act through glass where ordinary heat rays (5 to 6 mm.) will not, at any rate until the glass is warmed so as to allow the screen itself also to become warm: they act upon sulphide spread upon glass (instead of card) where heat rays will not until the glass is itself warmed: with a sunned screen of the green-fluorescent ZnS the infra-red puts out the phosphorescence while heat increases it: and if the screen be maintained at 0° the infra-red waves still produce their effect. After exhaustive exposure to infra-red waves the CaS screen cannot be re-excited to phosphorescence unless its temperature is raised above 100°: and the infra-red waves have dissipated the residue to the same extent as heating to 100° would have done.

Sulphide of strontium heated so as to deprive it of all residue, and exposed to light for too short a time to enable visible phosphorescence to be set up, will phosphoresce if heated to 225°. It is in the condition of invisible phosphorescence. Natural minerals which become phosphorescent on heating lose this property if the heating be kept up, and only feebly regain it on being sunned: their "residue" is exhausted. It is very improbable that this residue was stored-up luminous energy: it might be a quantity of products of decomposition, capable of reunion, with evolution of light, when the temperature became high enough. The minerals examined (including fluorspar) all shine on heating; and after exhausting their "residues" by heating, they shine feebly on sunning. Chlorophane does not shine indefinitely in the dark at 30° as it is said to do: this part of its power of phosphorescing has long ago been exhausted; what the heat of the hand brings out is the effect of some previous exposure to light, and forty-eight hours in darkness is enough to wear this away. Minerals cut in the dark from the interior of very large lumps, and which have therefore not seen the light for ages, shine upon being heated as well as if they had recently been exposed to light. They appear to contain the products of decomposition referred to. These tend to recombine and to be re-formed under the action of light; promptly and completely, in those minerals which phosphoresce after exposure to light at ordinary temperatures; incompletely under light in those which require higher temperatures. The diamond presents a difficulty if it be considered as pure carbon, for its behaviour is like that of alkaline earth sulphides; its phosphorescence can be wholly regenerated by light. Cape diamonds are hardly perceptibly phosphorescent: Brazil diamonds are brightly so (except black diamonds) for half an hour, and thereafter the phosphorescence can be restored by heating to 200° at any time. When the phosphorescence thus restored is exhausted (one hour at 200°) it can be completely restored by sunning; and the same even after many hours' heating at 600°. If the phosphorescence be due to foreign matters, which give the diamond its tint, these must be refractory at the temperatures employed. Polished diamonds are not more phosphorescent than rough. On calcination, say for fifteen hours, minerals mostly lose all power of having their phosphorescence regenerated by light; the violet amethyst becomes as clear as glass, and appears to lose something essential: other substances can after this treatment have the power restored by passing electric sparks through them for some time; the longer the spark (up to 15 cm.) and the longer the time (say five minutes) the brighter the restored phosphorescence. It appears, however, that there must have been some trace of this power left in the body so treated: perfectly pure sulphides of Ca, Ba, Sr, and Zn, which are not phosphorescent, are not made phosphorescent by this treatment. In most cases calcination does not drive out the foreign components, but alters the chemical relations, which are restored by the electric sparks.

The "residue" of phosphorescent power stimulated into activity, say by a temperature of 100°, becomes exhausted if this temperature is kept up: when it is exhausted, a temperature of 200° will bring a fresh portion of the residue into play: and so on up to say 500° or 600°; but heating to 100° for months will not encroach upon that portion of the residue which comes into activity only at temperatures above 100°; and so forth. A body incompletely exhausted at 500° and then cooled down and reheated to 200° will not shine, for all that portion of the residue is exhausted. There is no real distinction between bodies phosphorescent under heat and those phosphorescent under light. A body cannot become luminous by phosphorescence unless it is warm enough.

Phosphorescence produced by shocks or blows appears not to be due to any localised high temperature, but apparently to a conversion of energy propagated after the fashion of an explosion. The oxygen of the air plays no part. The phosphorescence is brighter in a vacuum (mercury vacuum type). Uranium is phosphorescent by friction only: most substances in this class are phosphorescent under heat or light. Calcination does not interfere with the phosphorescent power under the head. Cape diamonds are very phosphorescent under friction.

Phosphorescence under Röntgen rays is very feeble, while fluorescence is bright. Kathode rays and high-frequency emanations also are noted.

Phosphorescence accompanying chemical reactions.—Oxidation (? hydration and dehydration, with production of PH_3) of phosphorus. Sulphate of quinine, heated 150° to 200° C., dehydration; again on hydratation by absorption of moisture on cooling and contact with damp air: and the heat as a dehydrator may be replaced by a little anhydrous phosphoric acid, with similar results. Sulphate of cinchonine the same. Ordinary magnesia, commercial sulphate of lime and hydrate of alumina phosphoresce on dehydration only, and this requires temperatures of about 500°. In living beings we probably have hydration and dehydration. In radio-active bodies we have a phosphorescence readily lost by hydration and by heat; which points to chemical reactions rather than to atomic properties as the cause: the energy being supplied by infra-red radiations from surrounding walls, these calling forth the reactions which result in phosphorescence.

Perfectly pure substances are not phosphorescent. Traces of other substances are necessary: sulphide of strontium, for example, needs one part per 10,000 of a salt of manganese or bismuth (Mourelo). Sulphide of calcium has different phosphorescences according to the source of the lime.

Phosphorescence of living beings is now known to be practically universal in deep-sea life (Monaco expedition collections). Luminiferous bacteria on stale fish: cultivated in flasks (Paris Exhibition "Lumière vivante"). The phenomenon survives the life of the animal, but deprivation of air and moisture stops it. The spectrum varies according to the animal. The light can be reflected and polarised. Stale fish can be photographed with two minutes' exposure. Phosphorescence is apparently due to chemical reactions (hydration and dehydration, possibly).

Fluorescence is explicable on principles of resonance: but protracted phosphorescence, visible and invisible, seems hardly so. It seems to be due to chemical reactions going on even within the solid, and yet extremely mobile, so that they can be set up or arrested in fractions of a second, and reversible, but also dependent upon the temperature, so that the combination is promptly broken up by a very high temperature, slowly by a lower, and not at all at a sufficiently low, temperature. This points towards some new field in chemistry, a region of unstable compounds where the singular action of mere traces comes into play. The author has already obtained some singular results in the chemistry of mere traces and their effect upon the elements with which they are combined. A. D.

617. *Fluorescence and Chemical Composition.* **J. T. Hewitt** and **B. W. Perkins.** (Chem. Soc., Journ. 77. and 78. pp. 1324–1334, Dec., 1900.)—It is well known that whereas the tetrabromo- and tetraiodo-derivatives of fluorescein show marked fluorescence in alkaline solutions, the corresponding nitro-compound exhibits no trace of this property. From experiments on di- and tetra-nitro-fluorescein, the authors conclude that the introduction of nitro-groups into the fluorescein molecule in the ortho-position relatively to the hydroxyl groups prevents fluorescence in alkaline solutions, owing to the usual phenol-lactone and quinonoid-carboxylic acid tautomerism of fluorescein being inhibited by a secondary tautomerism between the nitro- and phenolic hydroxyl groups. At the same time the pyrone ring is so much weakened that water is readily added on with production of a true phthalein. T. H. P.

REFERENCES.

618. *Apparatus for Comparison Spectra.* **W. H. Wright.** (Astrophys. Journ. 12. pp. 274–278, Nov., 1900.)—The new accessory apparatus, consisting of adjustable prisms and electrodes, made for the Mills spectrocope of the Lick Observatory, is described in detail with figures of the parts in position. C. P. B.

619. *Periodic Vibrations of a Line Spectrum.* **E. Riecke.** (Phys. Zeitschr. 2. pp. 107–108, Nov. 17, 1900.)—Modification of the differential equations by introduction of terms for acceleration. Full paper to appear in Annalen d. Physik [*cf.* Abstract No. 825 (1900)]. A. D.

620. *Incandescent Gas Mantles and Burners.* **V. B. Lewes.** (Soc. Arts, Journ. 48. pp. 841–847, Oct. 19; 853–859, Oct. 26; and 865–873, Nov. 2, 1900.)—This paper is a reprint of a series of three Cantor Lectures on the above subject. In the first Lecture the author traces the origin and development of the production of light by the heating of refractory bodies to incandescence and treats of the preparation and use of the "mantle," the employment of thoria as the basis of the mantle and the effects of traces of other oxides on the light emissivity of thoria. Descriptions of the various thoria-ceria mantles, such as the "Welsbach," the "Voelker," the "Daylight," and the "Crown" mantles are given. Lecture II. deals, firstly, with the several theories which have been advanced to explain the enormous increase of luminosity produced by the addition of one part of ceria to 99 of thoria in preparing the mantles. The view generally accepted at the present time is that of O. Bunte, who considers that the small quantity of ceria present causes a catalytic action of the same kind as the heating of clean platinum-foil by a stream of mixed coal-gas and air, the ceria being by this means heated to a higher temperature than that of the flame. Next the sources of the rare earths are treated of and the attempts made to improve, or alter the composition of, the ceria-thoria mixture; the use of collodion for the purpose of obtaining a coherent mantle is also dealt with. In Lecture III. are described the various forms of burner employed for heating the mantles and their modes of action. T. H. P.

HEAT.

621. *A New Recording Air Pyrometer.* **W. H. Bristol.** (Mech. Eng. 6. pp. 916-917, Dec. 29, 1900. Paper read before the American Society of Mechanical Engineers, N.Y., Dec., 1900.)—This instrument consists of a porcelain bulb connected by a capillary tube made of seamless copper to a recording pressure gauge. The recording gauge is constructed with two tube springs formed on the Bourdon principle. Each spring consists of a tube of closely flattened cross section made into a helix of two complete turns. One of these springs is attached to the capillary tube and porcelain bulb, and the air is almost exhausted from the system. Although this subjects the bulb when cold to almost the full atmospheric pressure, yet when it is heated and the remaining air contained in it expands, the effect is to expose the bulb when in a weakened condition to only a very small strain. The air is also partially exhausted from the other tube spring, which is mechanically attached to the free end of the indicating tube spring. The object of this is to fit it to act as a compensating spring for barometric and thermometric changes. It is fixed so as to turn in the opposite direction to the other spring when both are under the influences of these changes. Barometric and thermometric corrections being thus eliminated, it is only necessary to calibrate the instrument according to the theory of the air thermometer.

F. J. R.

622. *Compressibility of Fluids.* **O. Tumlirz.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 837-848, June and July, 1900.)—From the equation of van der Waals, applied to rarefied gases, the author deduces the relations—

$$-\frac{1}{v}\left(\frac{\partial v}{\partial p}\right)_{T} = 12{\cdot}225m\frac{(v-a)^2}{Tv}$$

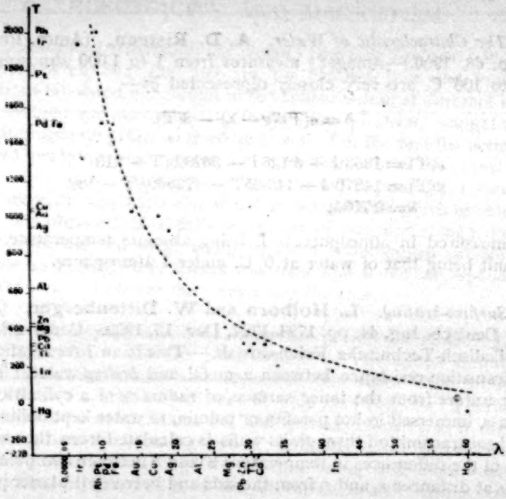
$$v_1 - v_n = 12{\cdot}225\, m\frac{(p_n - p_1)(v_1 - a)}{T}(v_n - a),$$

v being the volume in cubic metres of 1 kilogram of the gas, m its molecular weight, p being measured in atmospheres, and v_1, v_n being the specific volumes corresponding to pressures p_1, p_n. On comparison with the experimental results of previous investigators in reference to water, carbon bisulphide, mercury, the ethyl, methyl, amyl, and propyl alcohols, ethyl ether and benzene, it is found that the above formulæ may be made to represent the behaviour of the fluids by a suitable choice of the constant a.

Tables are given which show the close agreement at ordinary temperatures between the observed values of the coefficients of compression and those calculated from the formulæ. From the consideration of two vapours, at the same temperature, below their critical temperature, occupying equal volumes and under equal pressures, isothermally submitted to continually increasing pressure, it appears that the ratio of their ultimate volumes will be equal to the ratio of m_1a_1 to m_2a_2, where a_1 and a_2 are the values of the constant a for the fluids under consideration; therefore, the molecular volumes are in the same ratio and the diameters of the molecules as the cube root of this ratio. Thus the values of the constant a afford a means of comparing the size of the molecules of different liquids.

W. E. T.

623. *Relation between Coefficients of Expansion and Melting-points of Metals.* — **Lémeray.** (Comptes Rendus, 131. pp. 1291–1293, Dec. 31, 1900.)—From experimental data the author concludes that if pieces of different metals have equal volumes at absolute zero, their volumes will again be equal to one another at their respective melting-points. Thus, if λ be the coefficient of linear expansion and T the absolute temperature, then $T\lambda = \text{constant}$. The annexed diagram, in which the dotted line represents $T\lambda = 0{\cdot}02$, shows that in the case of the sixteen metals considered the conclusion is verified as accurately as could be expected. J. E. M.



624. *Critical Temperatures of some Sulphuretted Compounds.* **L. Ferretto.** (N. Cimento, 12. pp. 288–290, Nov.–Dec., 1900. From the Gazz. Chim. Ital. t. 30. I., 1900.)—The following results were obtained :—C_2H_5HS, 228° ; $(CH_3)_2S$, 231·2° ; $(C_2H_5)_2S$, 284·67° ; $(CH_3)(C_2H_5)S$, 259·66° ; $(C_5H_{11})HS$, isoamyl sulphhydrate, 334° (with reserve, on account of a slight decomposition), or by Pawlewski's method of mixtures (with ether), 330·92° ; isoamylic sulphide $(C_5H_{11})_2S$, 391·25° by method of mixtures ; $(C_3H_5)_2S$, 380·38° ; $(C_2H_5)_2S_2$, 368·93°. The ratio between the critical temperature and the boiling-point at 1 atmosphere, in degrees absolute, is about 1·55 in all these cases. A. D.

625. *Liquefaction of Gaseous Mixtures.* **F. Caubet.** (Comptes Rendus, 131. pp. 1200–1202, Dec. 24, 1900.)—The author summarises the inferences which can be drawn from the form of the isothermals of the groups of gaseous mixtures previously obtained by him. (See Comptes Rendus, Jan. 22 and Mar. 26, 1900). For a point moving along the *line of ebullition,* the excess of the inclination to the axis of the tangent to the isothermal for the homogeneous condition over that of the tangent to the isothermal for the mixed condition commences by being positive. As the point approaches the critical point, this excess diminishes, vanishing at the critical point ; it then becomes negative, diminishes to a minimum, and then increases, reaching zero again at the point of contact of the limiting isothermal, becoming positive and continually increasing as the moving point descends along the *dew-point* line. These experimental results entirely agree with the hypotheses and deductions of Duhem. [See further Abstracts Nos. 2004 and 848 (1900).] W. E. T.

626. *The Characteristic of Water.* **A. D. Risteen.** (Amer. Phys. Soc., Bull. 1. p. 63, 1900.)—Amagat's measures from 1 to 1,000 atmospheres and from 0° to 100° C. are very closely represented by—

$$p = \alpha(T)/(v - \lambda) - \beta(T),$$

where—

$$\begin{aligned}\alpha(T) &= 1363{\cdot}1 + 3{\cdot}126T - 36292/(T - 210)\\ \beta(T) &= 14870{\cdot}3 - 14{\cdot}565T - 479360/(T - 182)\\ \lambda &= 0{\cdot}7085,\end{aligned}$$

p being measured in atmospheres, T being absolute temperature, and the volume-unit being that of water at 0° C. under 1 atmosphere. R. E. B.

627. *Surface-heating.* **L. Holborn** and **W. Dittenberger.** (Zeitschr. Vereines Deutsch. Ing. 44. pp. 1724–1727, Dec. 15, 1900. Communicated by the Physikalisch-Technische Reichsanstalt.)—This is an investigation of the calorific transition-resistance between a metal and *boiling* water. The drop Δ in temperature from the inner surface, of radius r_0, of a cylindrical vessel of red brass, immersed in hot paraffin or palmin, to water kept boiling within it by the heat transmitted through its walls is calculated from thermoelectric measures of the differences in temperature S′ and S between two points in the solid walls at distances r_2 and r_1 from the axis and between the latter point and the water respectively; for—

$$\Delta = S - S' \log (r_1/r_0)/\log (r_2/r_1),$$

and the flow of heat Q through the inner surface is—

$$Q = KS'/r_0 \log (r_2/r_1),$$

if K is the conductivity. From four different series of experiments, 82 in all, with K = 0·169, the author finds—

$$\Delta = 0{\cdot}782 + 3{\cdot}69Q,$$

so that the transition-resistance $R \equiv \Delta/Q$ is thus equivalent to the resistance of a thickness of iron (of conductivity 0·145) equal to—

$$0{\cdot}145R = 0{\cdot}534 + 0{\cdot}113/Q = 0{\cdot}534 + 7{\cdot}59/P \text{ cm.},$$

where P is the number of kilos of steam generated per square metre per hour (since $P/Q = 36{,}000/536$). This holds for values of Q between 0·07 and 0·6 or for values of P between 4·7 and 40.

When the water is made to boil by the passage into it of steam, and the heat travels outwards, a series of twenty-six experiments shows the transition-resistance R (and not Δ) to be a linear function of Q and to be equivalent to the resistance of a thickness

$$0{\cdot}458 + 1{\cdot}91Q = 0{\cdot}458 + 0{\cdot}028P \text{ cm.}$$

of iron. R. E. B.

ELECTRICITY AND MAGNETISM.

628. *Atmospheric Electricity and Actinic Power of Sunlight.* **H. Mache.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 656–694, June and July, 1900.)—Observations tabulated, of sunlight in the Indian Ocean at different heights of the sun, sunlight and atmospheric potential slope at Delhi, sunlight in Ceylon and the atmospheric potential slope at Luxor. For the first the actinic power was found greater when the sun was high than any of the usual formulæ show. At Delhi the mean values of the potential slope and the water-vapour pressure were 127 and 8·5, which is not in accord with previous results; and evidence was obtained of a daily maximum of potential slope; the average potential slope was too small, being 36 for a water-vapour pressure of 8·3. The afternoon actinism was always less than that at the corresponding time in the forenoon. In Ceylon the reverse was the case. A. D.

629. *Electric Dispersion in Free Atmosphere at different Places.* **J. Elster.** (Phys. Zeitschr. 2. pp. 113–116, Nov. 24, 1900.)—The author describes tests made in 1900 from Bincra and Algiers to the North Cape. There is an increase of the dispersion-coefficient at mountain heights. There is also a great difference between continental and oceanic climates, as if the air were positively ionised by breaking waves; and this is the better marked the further north the station, negative charges being lost more rapidly than positive. The absolute values of the coefficient, apart from the signs of the charges, do not seem to depend much on the latitude. The values of the coefficient fall as the moisture increases, even before there is any visible formation of water-drops. A. D.

630. *Telluric Electricity.* **C. Liebenow.** (Elektrotechn. Zeitschr. 21. pp. 962–966, Nov. 15, 1900. Paper read before the Elektrotechn. Verein.)—This paper deals with atmospheric electricity, thunderstorms, and polar lights. Le Cadet observed in balloon ascents a p.d. of 86·5 volts per metre at an altitude of 1420 m., and of 13·4 volts per metre at an altitude of 4015 m. Assuming those figures to be substantially correct, Liebenow calculates that the whole surface of the earth would bear a negative charge of 300,000 coulombs, 2 electrostatic units per sq. m. The same quantity of positive electricity would be in the air under a serene sky, and an air cube of 10 m. edge would contain 0·65 units near the earth surface, and only 0·02 of this quantity at an altitude of 10,000 m. The p. d. between the earth surface and universal space would be —164,000 volts. If this electrification were due to ionisation (Elster and Geitel) caused by radiation, then the electrification should be reduced to half its value within an hour after sunset, and to ¼ per cent. in ten hours, and should disappear, therefore, during a long night. But we have electric maxima and minima during the night as well as during the day. Ascending heat currents, however, would carry positive electricity to the upper strata, and the author calculates that these currents would account for the p.d. observed.

A drop of rain in the clouds will assume a positive or negative charge, according as it is colder or warmer than the surrounding air. When the ascending air cools, the drops will, for a while, keep their higher temperature and become negatively charged within a positive shell of air ; the cloud as a whole will not appear electrified. When the drops increase in size, they will no longer float with the air from which they were condensed, but lag behind; thus the cloud will become positive above and negative below. Our electric instruments will not be affected, until a wind has separated the lighter positively charged portions from the negative. The falling drops may come into warmer strata again and change their polarity. A difference of 1° C. between the globules and the ambient air would suffice to produce a quantity of 8 coulombs in a sphere of 800 m. radius with a p.d. of 100 million volts. We know little about the energy of lightning-flashes. But Humphrey's observations on the influence of spark length exercised by small negative discharges should modify our views. The above figures would involve considerable energy, in any case, and that energy would not be derived from the thermo-currents, but from gravity, which causes the raindrops to descend. It is noteworthy that no allusion is made to rainless thunderstorms.

The polar lights would be due to brush discharges between ice needles (often seen to fall after polar light displays), which play the part of the raindrops. Such discharges are started by winds, and occasionally by radiations from sunspots, which the author regards as breaks in the metallic vapour envelope around the incandescent gas sphere. Polar lights sometimes—not always—affect the magnetic needle. Paulsen and Vedel observed in Greenland—*i.e.*, E. of the magnetic pole—that polar lights, apparently of low altitude, deflected the needle to the W. when they were approaching from the S., and to the E. when they had passed over them to the N. in their usual course. The opposite applies to Point Barrow, W. of the pole, and the rule for this deflection by polar lights in motion was already recognised by John Franklin in 1820. The deflection cannot be due to electrostatic charges. It is caused by the electric currents, circulating in ascending atmospheric currents of thermal character, when rendered conducting through ionisation by radiations. The magnetic needle moves owing to induction, resulting when these ascending currents cut the terrestrial magnetic lines of force. This view would also explain the diurnal variation in the magnetic elements.

H. B.

DISCHARGE AND OSCILLATIONS.

631. *Inconstancy of Spark Potential.* **K. R. Johnson.** (Ann. d. Physik, 3. 3. pp. 461–470, Nov., 1900.)—This paper supports Jaumann's of 1895, which has since been much discussed in the *Annalen*, and which asserts, among other things, the presence of oscillations during the charging of a Leyden jar by means of an influence machine. This latter having been contradicted by Precht (1898), Johnson holds that Faraday proved it long ago by electrolysing water by a statical machine, and showing that H and O are given off at both electrodes. Johnson has carried out the electrolysis, using one electrode only; and he supports Heydweiller on the point that the capacity of the Leyden jar does not influence the sparking potential. But he shows, by a mathematical example, that the expected damping of dE/dT is not confirmed, and deduces that the potential undergoes oscillatory changes which can explain, for example, the above electrolytic experiment. The case is also considered where the sparking potential is very large compared with the variation of potential at the spark micrometer ball, and the equation, $E = a + b\lambda$, connecting sparking potential (E) with length of spark-gap (λ) is again deduced.

G. E. A.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

632. *Volta Effect.* **Q. Maiorana.** (N. Cimento, 12. pp. 196–207, Sept.-Oct. 1900. Accad. Lincei, Atti, Aug. 19, and Sept. 2, and 16, 1900.)—Discussion of the contact theory and the chemical theory, and an experimental investigation. The method of measurement is by bringing the two metals to an equal potential, so that a charged silvered quartz filament is not attracted towards either. Low temperatures do not alter the order of the voltaic series, but so far reduce the volta effect that it would appear that at absolute zero there could be no such effect; for example, Zn/Au gives 0·88 volt in the atmosphere, 0·05 on dropping liquid air on; Al/Au similarly, 1·05 and 0·09; Fe/Au, 0·41 and a non-measurable result. When the original temperature is regained the original voltage is not recovered—*e.g.*, after one hour we have Zn/Au 0·78 only, Al/Au 0·82, and Fe/Au 0·25; as if the surface condition had altered. Measurements are given of the attraction between discs of different metals, by a balance and interference-fringes method, the fringes travelling as the discs slowly move towards one another. The mathematics of the method, including a null-method which eliminates the effect of Newtonian attraction, are also discussed. A. D.

633. *Deformation of Condensers.* **M. Cantone** and **F. Sozzani.** (N. Cimento, 12. pp. 155–164, Sept.-Oct., 1900; more fully in Rendic. dell' Istituto Lomb. 33. p. 1059, 1900.)—Experimental determination of the constants. It appears that the dielectric constant increases appreciably with increase of pressure. A. D.

634. *Coherers and Sound-Waves.* **E. Drago.** (N. Cimento, 12. pp. 191–195, Sept.-Oct., 1900: Atti Acc. Gioenia di Catania, vol. 13. ser. 4.)—Upon the formation of Chladni figures on vibrating plates with fine carbon powder, the electric resistance is greatly reduced; in some cases a minimum is reached before the final condition is attained. The electric current passes along each nodal line. Raising the pitch of the sound generally increases the conductivity, the nodal lines being the most numerous. In ordinary coherers the diminution of resistance seems to be due to the transport of the powder from ventral to nodal regions, perhaps into such intimate contact that adhesive forces come to some extent into play. A. D.

635. *Electric Discharge in Closed Volumes of Air.* **H. Geitel.** (Phys. Zeitschr. 2. pp. 116–119, Nov. 24, 1900.)—The loss of electric charge is not proportional to the charge, but remains nearly constant between 80 and 240 volts. The conclusion of the paper is that for every given temperature and pressure of air there is a corresponding percentage of ions and a corresponding conductivity; and that when the percentage of ions is reduced by electric forces, ions are regenerated to restore equilibrium. Daylight and artificial light make no observable difference. A. D.

636. *Nernst Filaments.* **W. Nernst** and **W. Wild.** (Zeitschr. Elektrochem. 7. pp. 373–376, Dec. 20, 1900.)—This paper describes life and efficiency tests of Zirconia, Thoria, and Yttria filaments, but does not mention what differences there are in the behaviour of the three oxides. The filaments begin to conduct at temperatures varying from 500° to 700° C. The change of conductivity with temperature is as follows:—

Temperature C....	500°	700°	800°	900°	1,000°	1,100°
Conductivity ...	0·03	0·16	0·64	1·84	3·6	9·9

Figures are given of efficiencies at different currents for four sizes of filaments; one filament, 23 mm. long and 0·6 mm. diameter, gave 18·6 candles with 0·25 ampere, at an efficiency of 2·32 watts per candle, and 227 candles with 0·8 ampere at an efficiency of 0·61 watts per candle. As an example of a life test, a filament running at an efficiency of 1·27 watts per candle and 184 volts, after 522 hours, had an efficiency of 1·50 watts per candle, but was not burnt out. G. H. B.

637. *Portable Apparatus for Testing Cables.* **M. T. Edelmann.** (Elektrotechn. Zeitschr. 22. pp. 79–80, Jan. 24, 1901.)—This apparatus comprises an ebonite slab on which are mounted the necessary terminals, resistances, condenser, plug-switches, keys, &c., for measuring (*a*) the insulation resistance, (*b*) the capacity, and (*c*) the resistance of the conductor, of a cable. There are three terminals to which the ends of the cable and the earth are respectively connected, these terminals being mounted on bars which can be connected by plugs to blocks joined up to the several sets of testing apparatus, *e.g.*, the galvanometer and standard resistance (10,000 ohms) for the (*a*) test; to the ballistic galvanometer and standard condenser (0·5 microfarad) for the (*b*) test; and to a dial-pattern bridge for the (*c*) test. This bridge has centrally pivoted contact arms instead of plugs. A set of shunts for the galvanometer can also be mounted on the board. A photograph of the apparatus and a series of diagrams, showing the connections for the several tests, are given in the original paper. C. K. F.

638. *Sticking of Relay with Condenser Shunt.* **W. O. Pennell.** (Elect. World and Engineer, 36. p. 808, Nov. 24, 1900.)—The author found that the contacts of a closely adjusted relay when bridged by a condenser had a tendency to stick, and he has investigated the cause of this. He attributes the effect to charges, produced by the condenser, collecting at the contact points, and exercising an attractive action. It may be avoided by introducing resistance into the condenser circuit. G. H. B.

639. *Potentiometer.* **N. T. M. Wilsmore.** (Elektrotechn. Zeitschr. 21. pp. 997–998, Nov. 29, 1900.)—Two series of sixteen coils, of a total resistance of 10,000 ohms each, have their contact pieces arranged in two parallel rows, so that each coil in one row is opposite a coil of equal value in the other. The coils are in series of 1, 1, 2, 5. On a central axis, between and parallel to the two rows of contacts, are sixteen two-way switches, which short-circuit either one or the other of two opposite coils. Half the total resistance of 20,000 ohms is always short-circuited by these switches, and the 10,000 ohms always in circuit can be distributed between the two rows as desired. One row is marked in ohms and the other in volts, 1 volt being made equivalent to 5,000 ohms; the bridge is then direct reading, when a potential of 2 volts is maintained on the two rows in series, and the unknown potential is connected in series with a galvanometer to the row marked in volts. The bridge is standardised as usual by a standard cell connected in place of the unknown potential. Higher potentials may be employed, but the bridge is then not direct reading. G. H. B.

640. *Ammeter and Voltmeter with Adjustable Field.* **Menges.** (Soc. Franç. Phys., Bull. 155. p. 2, 1900.)—The instrument is of the d'Arsonval type, and the permanent magnet is provided with an iron piece, acting as a magnetic shunt, the position of which can be adjusted by a screw. The iron core,

between the poles of the magnet, is capable of a slight eccentric motion about a horizontal axis, so that the attractions of gravity and of the magnet tend to move it in opposite directions. The magnetic shunt is adjusted until these two attractions are in equilibrium—a condition which corresponds to a definite strength of field in the air-gap. With a variation of 30 per cent. in the strength of the magnet, the strength of the field can in this way be adjusted to within 1 per cent. G. H. B.

641. *Ebert-Hoffmann Electrostatic Voltmeter.* **C. Bäumler.** (Elektrotechn. Zeitschr. 21. pp. 1015–1016, Dec. 6, 1900.)—The voltmeter consists of an aluminium ellipsoid suspended between two parallel metal discs, fixed in vertical planes. The deflections are read by a mirror and scale. The zero point is at a position in which the major axis of the ellipsoid is at an angle of 45° with the normal to the discs. The oscillations of the ellipsoid are damped by the action of a magnetic field on a copper cylinder fixed below the ellipsoid. The ellipsoid is suspended by a bifilar suspension from a torsion head, which affords a zero adjustment. The distance between the upper ends of the two fibres of the suspension can be varied by the insertion of distance pieces provided with the instrument. The discs also can be fixed at different distances, one from the other. Their diameter is 270 mm., the major axis of the ellipsoid is 29 mm. With the discs separated by 26·5 mm., 3,000 volts gave a deflection of 100 mm. at 1 m. distance. The constant was found to diminish with increase of pressure; between 2,000 and 10,000 volts, there was a variation of 3½ per cent. in the constant. G. H. B.

642. *Ebert-Hoffmann Electrostatic Voltmeter.* **A. Schwartz.** (Elektrotechn. Zeitschr. 21. pp. 1076–1077, Dec. 20, 1900.)—The author refers to the tests on this voltmeter made by Bäumler [see preceding Abstract], in which the constant was found to diminish regularly with increase of deflection. His own experiments, however, show no regular variation in the constant, which throughout his measurements does not vary more than 1 per cent. from its mean value. He finds also that the constant is directly proportional to the distance between the discs. G. H. B.

643. *Calibration of Resistance Bridges.* **M. T. Edelmann.** (Elektrotechn. Zeitschr. 21. pp. 912–913, Nov. 1, 1900.)—This article describes the calibration of a plug resistance bridge against a standard ohm. The author recommends the substitution of a resistance of thick manganin wire for the copper piece connecting the bridge resistance with the ratio arm, so as to bring the resistance of the plug-contacts to a definite value, such as 0·005 ohm; a balancing resistance can then be added to the standard ohm, when making exact comparisons. The comparison of the bridge ratios is greatly facilitated in the bridges constructed by the author, in which the connections of the ratio arms can be reversed. [See following Abstract.]
G. H. B.

644. *Resistance Bridges with Reversible Ratios.* **M. T. Edelmann.** (Elektrotechn. Zeitschr. 21. pp. 979–980, Nov. 22, 1900.)—This article describes, with seven illustrations, four different types of resistance bridges, designed by the author, with connections enabling the two ratio arms to be interchanged [see preceding Abstract]. In the P.O. type of bridge the two ratio arms are parallel to each other, each with plug connections at either end to the ends of a brass piece running between them; the

bridge terminal at one end, and the connection to the bridge resistance at the other end of the ratio arms, can be connected to either arm by a plug. In the plug-dial and switch-dial types, a pair of terminals, with plug-connection between, is fixed at each end of the two ratio arms, which are permanently connected in series. The unknown resistance is connected to one pair, and the other carries an ebonite piece with the galvanometer and battery keys and terminals, with cord connections to the bridge. Interchanging this with the unknown resistance reverses the ratio arms. G. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

645. *Viscous Hysteresis.* **K. Krogh** and **H. Rikli.** (Elektrotechn. Zeitschr. 21. pp. 1083–1086, Dec. 27, 1900.)—Two rings were used by the authors in their experiments; most of the measurements were carried out with the first ring, which contained 7·792 kg. of iron, and was built up of discs 0·3 mm. thick, having an external diameter of 20·2 cm., and an internal one of 13 cm. The second ring was used only for checking the results obtained with the first, and consisted of discs 0·19 mm. thick. The total power absorbed by the iron was measured by a reflecting wattmeter. Curves were constructed connecting the total iron loss with the frequency for a *given constant value of the induction.* The eddy-current loss for each frequency was then calculated by means of Steinmetz's formula, and was subtracted from the total loss. The difference gave the hysteresis loss. The inductions used were 5,000, 10,000, and 15,000. In each case it was found that for a given induction the hysteresis loss per cubic cm. per cycle increased with the frequency, and the percentage increase was greater for higher values of the induction. Thus, at 50 cycles per sec. the loss was 10 per cent. greater for $B = 5{,}000$, and 30 per cent. greater for $B = 15{,}000$, than the loss corresponding to the static hysteresis loop. The authors next investigated the effect of wave-form, and found that *for a given maximum induction*, a peaked e.m.f. wave (and therefore a flat-topped induction wave) corresponded to a higher hysteresis loss. They remark in this connection that the result might have been anticipated, since with a flat-topped induction wave the changes in the induction are more rapid—except, of course, near the maximum points. Curves of p.d. and current were next determined, and from them the values of the permeability were deduced. The latter was found to decrease steadily, for a given maximum B, as the frequency increased. A. H.

646. *Residual Magnetism.* **P. Holitscher.** (Ann. d. Physik, 3. 4. pp. 683–719, Dec., 1900.)—The author's experiments were confined to a single ellipsoid of Jura iron, having axes 36 cm. and 0·288 cm. The method of measurement adopted was the magnetometric, with a magnetising coil 60 cm. in length. The results of the experiments are as follows: The residual magnetic moment reaches a maximum value only after magnetising for a certain time, from 1′ 15″ for $H = 0{\cdot}99$ to 2′ 30″ for $H = 3{\cdot}6$ or over. Repeated magnetisations, if in one direction only, give continually increasing residual moments; after 100 magnetisations, beyond which the author did not go, the residual moment was still on the increase. On the other hand, if the successive magnetisations are alternately in each direction, the maximum residual moment is acquired after the first or second; the maximum so reached is about 12 per cent. lower than that when the iron is magnetised in one direction only.

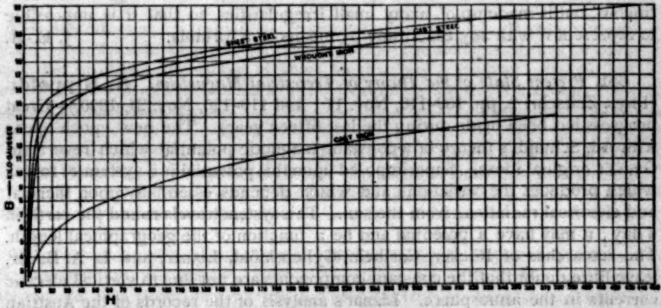
The magnetic moment due to the magnetisation is not affected, either by the duration of magnetisation [the author did not deal with very short periods], or by the number of magnetisations. The residual moment is somewhat smaller, if the magnetising force be removed suddenly, than if it be removed gradually, or by steps of not more than 8 per cent.; but a sudden and a gradual magnetisation has the same effect. Contrary to the generally accepted results, the author finds that a small value of H, amounting to 0·055, produces a residual magnetic moment equal to 6 per cent. of the "temporary" moment. The ratio of the residual to the temporary magnetism rises very rapidly from 35 per cent. for H = 0·6 to 70 per cent. for H = 0·72, and then descends to a constant value of 41 per cent. for H = 6·0.

In making the experiments, the iron was demagnetised after each reading; if this be not done, the maximum ratio is only 61 per cent. for H = 0·9.

Measurements of the hysteresis loss were made, and curves are given between the various quantities. The exponent of B in Steinmetz's law varied from 1·21 for B = 11,800 to 2·64 for B = 22. The author finally explains his results in the light of Wiedemann's molecular theory, assuming the existence of frictional or cohesion forces between the molecular magnets.

G. H. B.

647. *Tests of American Iron and Steel.* **J. W. Esterline** and **R. B. Treat.** (Elect. World and Engineer, 36. pp. 959–960, Dec. 22, 1900.)—These tests were made on more than one hundred samples received from twenty of the chief electrical manufacturing companies. The curves show the results for the best sample of each kind of metal. The poorest piece of sheet iron gave B = 9,900, 14,850, and 18,800, when H was 10, 100, and 450 respectively.



W. H. E.

648. *Lines of Induction in a Magnetic Field.* **H. S. Hele-Shaw** and **A. Hay.** (Roy. Soc., Phil. Trans. 195. pp. 303–327, Dec. 20, 1900; Roy. Soc., Proc. 67. pp. 234–236, Nov. 14, 1900 (Abstract).)—Stokes having shown theoretically and Hele-Shaw by experiment that the stream lines of a viscous liquid in a channel between two parallel planes near together, are identical with those of the two dimensional flow of a perfect liquid in the same channel [Abstract No. 978 (1899)], the authors now show that the stream lines found by experiment when the distance between the parallel planes varies, are identical with the lines of induction through media which differ in permeability. They investigate the relation between the variations of thickness and permeability, both by experiment and by theory, and find the two in accord. The apparatus used enables photographs of the colour bands which represent the lines of induction to be taken, and the paper contains reproductions of a large number of photographs of interesting cases of induction in and around solid and hollow prisms and cylinders, and through pole-pieces and armatures of dynamos of various types. The latter cases furnish valuable information on a subject of great importance to designers of electrical machinery. W. G. R.

649. *Secular Variation of Terrestrial Magnetism.* **P. S. Wedell-Wedellsborg.** (Ann. d. Physik, 3. 3. pp. 540–542, Nov., 1900.)—The author maintains that Paulsen's theory gives a correct explanation of the secular variation. The rotation of the negatively charged earth should produce a magnetic system with its axis coincident with the axis of rotation. This is, however, disturbed by a system of currents in the form of two half-ring shaped solenoids lying always on the sunlit side of the earth and producing in the northern hemisphere during the day a west to east magnetic force, which, acting on the principal system, tends to cause a drift of its axis in accordance with observed facts. J. E.-M.

650. *Secular Variation of Terrestrial Magnetism at St. Petersburg-Pawlowsk.* **H. Wild.** (Acad. Sci. St. Pétersbourg, Mém. 9. pp. 1–40, 1900.)—From series of observations extending over the greater part of last century, the author concludes that the secular variation in St. Petersburg is not continuous, but is made up of many small irregularities, so that it is impossible to represent it with any exactitude by means of a formula. J. E.-M.

651. *Present State of the Theory of Terrestrial Magnetism.* **A. Nippoldt.** (Phys. Zeitschr. 2. pp. 108–110, Nov. 17 ; and 119–125, Nov. 24, 1900.)—Great progress has been made during the last fifteen years. The new epoch opens with Ad. Schmidt's theory of a constant magnetic potential which reverts to Gauss's original ideas. Superimposed upon this potential is a system of forces which produces the variations and which depends essentially upon thermal and electrical radiations from the sun. This system travels round the earth in a day ; it may have a potential and be a function of the geographical length. The researches of Rücker, Carlheim-Gyllenskiöld, Liznar, and L. A. Bauer, leave little doubt that the constant components are not due to vertical electric currents in the atmosphere. Liznar's analysis of the records of the Austrian observatories, which are situated at different altitudes, seems to indicate, however, that there may be magnetic forces outside the earth. The conception of normal potential (von Bezold and Bauer) points to the existence of three pairs of poles, south poles in Africa, south of Australia, and south of the Aleutian Islands, and north poles in China, Southern Georgia, and North America. The constant magnetism may itself decrease or increase owing to losses of energy from the earth or movements of the solar system in space ; it seems to shift on the globe. According to Gyllenskiöld, the chief magnetic axis describes a cone of 23° 28′ about the rotation axis in 3147 years. This view would be compatible with the assumption of a magnetic sphere revolving in an electric field (Hertz) in the atmosphere, the field itself revolving in the opposite direction. We have no proof of the existence of such a field, but the view receives independent support by Schuster, A. Korn, and Wessely. The daily variations are certainly connected with meteorological conditions

(Bezold and Schuster). The influence of the sunspots period seems established (W. Ellis), not that of the sun rotation (26 days). Most magnetic disturbances become more marked in higher latitudes (Lüdeling). H. B.

652. *Magnetic Observations during an Eclipse of the Sun.* **L. A. Baue[illegible]** (Amer. Phys. Soc., Bull. 1. p. 64, 1900.)—Simultaneous readings of declination were made at six stations, three inside and three outside the belt of totality, covering an area from Alabama to Maryland. The horizóntal force was also determined by a torsion unifilar at one station within the belt. The author states that all the stations show a magnetic effect which cannot be referred to any other cause than that of the eclipse, the principal effect occurring, like the fall in temperature, some minutes after totality. The effect produced is as though part of the night hours were interposed among the day hours. Thus, in the case of the declination, which had passed the morning elongation, there was an increase of about 20″ to 40″, if the declination be east, and a decrease if the declination be west. The horizontal fo[illegible], which at the time was approaching its minimum value for the day, w[illegible]creased. W. W.

REFERENCES.

653. *Universal Shunt.* **Tuch.** (Archiv. Post Tele. 24. pp. 925–9[illegible]ec., 1900.)—A description is given of the Ayrton and Mather shunt for galvanom[illegible]s, and of the particular form of it adopted by the German Imperial Post Office. R. A.

654. *Measurement of Insulation Resistance of Cables.* **J. Rabi[illegible]wicz.** (Elektrotechn. Zeitschr. 22. pp. 98–99, Jan. 31, 1901.)—The author states tha[illegible]r comparing the insulation resistances of short lengths (say 1 yard) of cable[illegible]e has found Bright and Clark's accumulation method extremely useful. A diagra[illegible] the necessary connections is given. [illegible]H.

655. *Evaluation of Mutual Potential.* **E. Mathy.** (Journ. de Physique, 10. pp. 33–36, Jan., 1901.)—A mathematical note explaining a method of obtaining in the form of a rapidly converging series the value of the mutual potential of two parallel circular circuits carrying electric currents. E. H. B.

656. *Photoelectric Sensitiveness of Ice.* **H. Benndorf.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 695–698, 1900.)—The author denies Brillouin's statement [Abstract No. 1835 (1900)] that ice has any photoelectric sensitiveness, and rejects the theory of atmospheric electricity based upon this alleged property. A. D.

657. *The Vortex Theory of Atoms as Applied to Electrolysis and Kathode Rays.* **M. Frank.** (Elektrochem. Zeitschr. 7. pp 184–188, Nov., 1900.)—A discussion of electrolytic phenomena, Faraday's law of constant electrochemical equivalent, &c., on the vortex theory of atoms, with suggested explanations of Lenard's experiments, Boyle's law, and the behaviour of gases under compression. D. E. J.

658. *Pressure and Temperature in Electric Sparks.* **E. Haschek.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 866–877, 1900.)—A mathematical discussion of the relation of temperature and pressure along the line of electrical discharge in reference specially to the experimental work of Schuster. E. H. B.

659. *Terrestrial Magnetism in Obdorsk and Ssamarowo.* **H. Abels.** (Acad. Sci. St. Pétersbourg, Bull. 11. pp. 9–27, 1899.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

660. *Reaction Velocity and Equilibrium.* **W. D. Bancroft.** (Journ. Phys. Chem. 4. pp. 705-708, Dec., 1900.)—The author considers the equilibrium between ammonium carbonate and its dissociation products, all in the gaseous state, assuming (1) that the reaction takes place in one stage according to the equation—

$$2NH_3 + CO_2 \rightleftarrows NH_4CO_2NH_2,$$

and (2) that there are two stages to the action, represented by the equations—

$$(a)\ NH_3 + CO_2 \rightleftarrows NH_2.CO_2H$$

and— $$(b)\ NH_3 + NH_2CO_2H \rightleftarrows NH_4CO_2NH_2.$$

In the first case the equilibrium equation is—

$$Kx = (A - x)^2(B - x),$$

and in the second—

$$Kx = (A - x - y/2)^2(B - x - y);$$

where 2A and B represent the initial concentrations of NH_3 and CO_2 respectively, and x and y the concentrations at any moment of $NH_4CO_2NH_2$ and NH_2CO_2H. If y is zero, *i.e.*, if the NH_2CO_2H is used up as fast as formed, the reaction would be of the second order if the reaction velocity alone were studied, although the chemical equation would call for a reaction of the third order. It is therefore clear that abnormal reaction velocities may, and probably do, occur in the case of reversible reactions, despite the fact that irreversibility is often postulated as requisite to an abnormal reaction.

T. H. P.

661. *Chemical Equilibrium.* **O. Boudouard.** (Comptes Rendus, 131. pp. 1204-1206, Dec. 24, 1900.)—In continuation of his previous experiments [see Abstract No. 673 (1900)], the author verifies for different pressures the general law of the equilibrium of gaseous systems. He studies the action of carbon dioxide, diluted with nitrogen, on carbon, verifying the formula due to Le Chatelier, and finding that the rate at which the reaction occurs is lessened by diminution of pressure in confirmation of the law enunciated by Le Chatelier (Comptes Rendus, 128. p. 1524). The above formula determines the composition of the gaseous mixtures resulting from the action of air on carbon at different temperatures, and a table is given accordingly.

W. E. T.

662. *Evolution of Heat on Wetting Powders.* **M. Bellati.** (N. Cimento, 12. pp. 296-300, Nov.-Dec., 1900. From the Atti del R. Istituto Veneto. T. 59. pp. 931-947, 1900.)—The author discusses the two theories put forward to explain the development of heat when a powder is moistened with water. According to the first, an enormous compression occurs in the stratum of liquid in contact with the surface of the solid, this being supported by the experiments of Bunsen showing that a very thin film of water remains on the surface of glass even at very high temperatures, and that carbon dioxide is extremely soluble in such a film. On moistening sand with water, Jungk found that below 4° an absorption of heat occurred, whilst

Meissner obtained heat development even at 0°. The author describes experiments made on the moistening of fine river sand with water, the changes of temperature being measured by means of a thermoelectric pile connected with a galvanometer. The cooling observed by Jungk is not noticed, and when the sand employed was previously dried by gentle heating, the change of temperature is in all cases several tenths of a degree. Heating is also obtained, although to a less extent, when sand containing less than 1·4 or more than 2·1 per cent. of water is moistened with its own weight of water; when the content of water lies between 1·4 and 2·1, the results are inconclusive, in some cases cooling and in others heating taking place. Any cooling which does take place at temperatures below 4° with suitably moist powders is very slight, and the observations of Jungk must be regarded as inaccurate.

The second hypothesis, originated by Cantoni and expanded by Martini, supposes that the moistening of such powders (which are described as "hygrophile" owing to the fact that they absorb a certain amount of water without losing their pulverulent character) is in some respects analogous with the phenomenon of solution, the evolution of heat observed being due to the solidification of part of the water absorbed by the powder. Martini's measurements of the specific heat of such absorbed water gave a value of about 0·5; that is, the same as for ice and for the water of hydrated salts. On repeating these determinations by a more delicate and direct method, the author obtains for the specific heat of the absorbed water values differing but slightly from unity.

It is probable that the heat evolved when a powder is moistened with a liquid is the net result of the replacement of the free surface of the solid by a solid-liquid surface of contact and the addition of a liquid-air surface.

T. H. P.

663. *Chemical Compounds in Alloys.* **F. H. Neville.** (Brit. Assoc. Report (1900), pp. 131–149.)—This paper contains a description of the various methods employed for the detection of "intermetallic" chemical compounds, which are classified as follows: (1) Chemical methods, such as extracting the pure compound from an alloy by filtration, by volatilisation of excess of a volatile metal or by removing the excess of metal by means of a suitable solvent. (2) A study of the chemical equilibrium of the mixed metals, most conveniently by the freezing-point curve. (3) Microscopic examination of the polished surface of the solidified mixture, after etching or oxidation. (4) Röntgen-ray photography. (5) The determination of the difference of electrical potential existing between a metal and its alloys. (6) Measurement of heat by formation, and (7) of the electrical conductivity. The results obtained by each of these methods are described in detail. The second part of the paper contains a list of the intermetallic compounds at present known, together with the evidence on which the formula of each is based and the name of the investigator. The results are also given of the work of the author and Heycock on the depression of freezing-point of the metals tin, zinc, bismuth, cadmium, and lead, caused by the solution of small quantities of other metals. T. H. P.

664. *Crystalline Structure of Metals.* **J. A. Ewing** and **W. Rosenhain.** (Roy. Soc., Phil. Trans. 195. pp. 279–301, Dec. 10, 1900; and Roy. Soc., Proc. 67. pp. 112–117, Oct. 26, 1900 (Abstract).)—This is the second paper by the authors on the same subject [see Abstracts Nos. 1196 (1899) and 1138 (1900)]. Attempts made to watch the alteration in structure by means of a microscope

during the heating of specimens failed; but by marking off a portion of the polished and etched surface, the structure of a specimen before and after the required treatment was examined under practically identical conditions, the surface being repolished and etched prior to each fresh examination. No satisfactory results have yet been obtained with iron, but it is shown that lead that has been rolled or subjected to severe mechanical stress gradually becomes more largely crystalline even at ordinary temperatures, the rapidity of the change increasing as the temperature rises; even at 200° C. a great alteration is produced in less than half an hour. Cast lead, unstrained, does not show these structural changes in the same way. Quenching at 200° or 300° C., even in liquid air, is without visible effect on the structure. No "arrest" point, similar to the "Ar" points of cooling iron, could be observed in the thermal (time-temperature) curve of cooling lead. In the case of pressure-welds of clean lead surfaces, although the crystalline structure altered on either side of the weld-line, in no case was a crystal observed to grow across the weld, unless flakes of a eutectic alloy of lead and bismuth (or other metal of low fusing-point) were sprinkled over the surface before making the weld. A complete layer of eutectic material had not the same effect, nor had particles of foreign matter such as sand or iron. This, taken with other observations—as, for example, the growth of certain individual crystals at the expense of others—has led to the evolution of the theory that the recrystallisation is due to the solution and diffusion of the pure metal-crystals into the eutectic film around them, and to the deposition of the metal on other crystals, the action probably being electrolytic and depending upon the presence of two crystals of unlike solution-pressure in contact at one part but separated otherwise by a film of eutectic alloy. This would explain the non-recrystallisation of cast metal (in which, it may be supposed, each metal-crystal is entirely surrounded and isolated from its neighbours by a thin film of eutectic, resulting from the presence of impurities) until the structure should have been broken down mechanically and adjacent crystals should have been in many cases pressed into contact. Tin, zinc, and cadmium each show the same tendency as lead to recrystallise after rolling. Photographs are given showing the changes described. W. G. M.

665. *Formation of Syngenite.* **J. H. van't Hoff** and **H. A. Wilson.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 53. pp. 1142–1149, Dec. 20, 1900.)—This is one of a series of papers [see Abstracts Nos. 226, 1114, 1116, 1879 (1900) and 528 (1901)] dealing with the theory of the formation of oceanic salt deposits, and more especially of the Stassfurt deposits. The conditions governing the formation and existence of syngenite—$CaK_2(SO_4)_2H_2O$—in solutions saturated with sodium chloride and the sulphates of sodium, potassium, and calcium at 25° have now been determined, and experiments have also been made with a view to the solution of the similar, but more complex, problem when magnesium salts are also present. Diagrams illustrating the results are given in the paper. N. L.

666. *Chemical Action of Rarefied Gases.* **A. Colson.** (Comptes Rendus, 131. pp. 1202–1204, Dec. 24, 1900.)—The author describes experiments which show that, apart from any electric or luminous stimulus, glass emits reducing gases, which are continually given off in presence of an absorbent, as though having a fixed pressure, and whose reducing power exceeds that of free hydrogen. Tubes were prepared, some containing red oxide and others yellow oxide of mercury; some of each were filled with hydrogen and

others exhausted to a vacuum of $\frac{1}{1000000}$. After exposure to light for some months distinct reduction of the oxides was obtained, and analysis showed that much more oxide was reduced than corresponded to disappearance of hydrogen in the one case or to reappearance of oxygen in the other. Similar results were obtained with a tube full of oxygen. In analogous tubes kept in the dark for the same time similar effects were produced, but to a much less extent. The author is investigating whether this effect is due to the chemical composition of the glass or to the passage of hydrogen through the glass, or to an increase in the activity of hydrogen corresponding to that of fluorine in the presence of hydrochloric acid or water. W. E. T

667. *Solvent Action of Vapours.* **A. T. Lincoln.** (Journ. Phys. Chem. 4. pp. 715–731, Dec., 1900.)—Vapour pressure curves were plotted for salicylic acid between 82° and 157°, and for benzoic acid between 71° and 193°, and experiments were then made to ascertain whether, in presence of other vapours, the partial pressures of the volatile acids ever exceeded their normal vapour pressures, the method being to analyse the distillate from a saturated solution in water, benzene, or acetone. The results were all negative in character, as also were those obtained in the case of alcoholic solutions of naphthalene and of camphor.

Above the critical temperature the solvent action of vapours has been demonstrated by Hannay and Hogarth (Proc. Roy. Soc. 30. 178, 1880) in the case of KI, KBr, and $CaCl_2$ in alcohol-vapour, sulphur in CS_2, resin in light petroleum, $CoCl_2$ in alcohol, &c., and similar results have been obtained by Villard, Victet, and Wood. T. M. L.

668. *E.M.F. due to Magnetisation of an Electrode.* **R. Paillot.** (Comptes Rendus, 131. pp. 1194–1195, Dec. 24, 1900.)—If, in a cell composed of two iron electrodes dipping into acidulated water, one electrode be magnetised, it becomes positive to the non-magnetised electrode; and, according to the experiments of Hurmuzescu, who used fields up to 7,000 c.g.s. units, the curve expressing the relation between impressed magnetic field and resulting e.m.f. of magnetisation is similar to the curve of magnetisation of iron. The author now extends these experiments to very strong magnetic fields produced by an electromagnet of the Du Bois type, giving a field of more than 30,000 c.g.s. units. The electrodes dip into the liquid in the vertical arms of a flat U-tube whose horizontal arm is of such a length that when one electrode is fixed between the poles of the electromagnet, the other is in a field which is negligible.

The conclusion from all the experiments is that, for a given acid and specimen of iron, the e.m.f. of magnetisation always tends towards a fixed maximum, the value of which depends somewhat on the kind of iron and particular acid used. W. C. H.

669. *P.D. between Solutions.* **M. Couette.** (Journ. de Physique, 9. pp. 652–655, Dec., 1900.)—A copper electrode was covered with a layer of normal copper sulphate, over which were layers of normal and deci-normal-sulphuric acid. A capillary electrometer showed a difference of −0·055 volt between the two layers of sulphuric acid, whilst Nernst's fomula gives −0·042. In a similar way the p.d. between normal and deci-normal zinc sulphate was found to be 0·006 volt, the calculated value being 0·010. T. M. L.

670. *Thermodynamics of the Hydrogen-Chlorine Gas Cell.* **I. Akunoff.** (Zeitschr. Elektrochem. 7. pp. 354–356, Dec. 6, 1900.)—The e.m.f. of a

hydrogen-chlorine gas cell is 1·37125 volts at 0°, 1·35685 volts at 18°, and 1·34221 volts at 36°. The heat of the reaction, as given by Helmholtz's formula, $q = E + T\frac{dE}{dT}$, is therefore 31,357 + 5,750 = 37,107 cal. This corresponds very closely with the value for the formation of HCl aq. from H_2 and Cl_2, which gives 39,300 cal., or allowing for the heat of dilution of the 3N solution used in the gas battery, 37,680 cal. The conclusion is drawn that the primary reaction which takes place in the battery is that represented by the equation $H_2 + Cl_2 = 2HCl$, and not the electrolytic reduction of either oxygen or hypochlorous acid, which might conceivably be formed at the chlorine electrode as the first products of the action. T. M. L.

671. *Gas Polarisation in Lead Accumulators.* **W. Nernst** and **F. Dolezalek.** (Zeitschr. Elektrochem. 6. pp. 549–550, May 10, 1900.)—On electrolysing dilute sulphuric acid between platinum electrodes the evolution of gas begins at 1·7 volts and is vigorous at 1·9 volts; between lead electrodes, however, no gas is liberated at this voltage, but lead and lead peroxide are produced at 2 volts, and the evolution of gas only begins when there is no lead sulphate on the plate and at a pressure of 2·3 volts. This is explained on the supposition that the occlusion of gas by platinum renders it possible to liberate it at a much lower voltage with platinum electrodes than with lead electrodes which do not possess this property. On passing a small current through the systems

$$Pt \mid H_2SO_4 \mid PbSO_4 \mid Pt \text{ and } Pt \mid H_2SO_4 \mid PbSO_4 \mid Pb,$$

it was found that in the second case there was a potential difference of 1·92 volts between the lead kathode and a lead peroxide electrode immersed in the solution, but a potential difference of only 1·60 volts in the case of the platinum kathode of the first system; the lead sulphate was completely reduced in the second system, but in the first system it was not reduced until a higher current density was used. This result is regarded as supporting the view that a high voltage is required to liberate gas from the lead electrodes, and the influence of mercury salts in raising the e.m.f. of an accumulator is similarly explained as due to an increase in the difficulty with which gas-bubbles are liberated. T. M. L.

672. *Gas Polarisation in Lead Accumulators.* **Strasser** and **Gahl.** (Zeitschr. Elektrochem. 7. pp. 11–13, 1900.)—On comparing lead with antimony and with lead-antimony alloys, it was found that hydrogen is most readily liberated from pure antimony and least readily from pure lead kathodes. T. M. L.

673. *Dissociation in Colloidal Solutions.* **M. G. Levi.** (N. Cimento, 12. pp. 293–296, Nov.–Dec., 1900. From the Gazz. Chim. Ital. t. 30. II., 1900.)—In order to find whether any exact relation exists between the internal friction of a solvent and the mobility of the ions of a dissolved salt, the author measures (1) the electrical conductivity of potassium iodide in water and in solutions of gelatine, agar-agar and silicic acid; (2) the depression of the freezing-point of potassium chloride and iodide in water and in solutions containing silicic acid and gelatine; (3) the velocity of inversion of sugar by dilute hydrochloric acid both in water and in silicic acid solution. Although the colloidal solutions employed have very great internal friction—the agar-agar solution, indeed, being solid at the temperature of the experiments—it is

found that for each of the three series of measurements the same results are obtained with the colloidal as with the aqueous solutions. The author therefore concludes that dissociation in colloidal solutions takes place in the same manner and to the same extent as in aqueous solutions. The only way of explaining these results seems to be by means of the reticular theory of colloidal solutions, according to which the molecules of a colloid are connected after the fashion of a network, so that in an aqueous colloid the water, and with it the ions of any dissolved electrolyte, passes freely through the meshes. T. H. P.

674. *Osmosis of Liquids.* **G. Flusin.** (Comptes Rendus, 131. pp. 1308–1309, Dec. 31, 1900.)—As in the case of vulcanised rubber [see Abstract No. 1013 (1898)], the rate of osmosis of different liquids through a membrane of bladder is dependent on the quantity of the liquid which is absorbed by unit weight of the bladder. This is shown by the following table, which gives (1) the velocity of osmosis in cubic millimetres per sq. dcm. per hour at 12° through the membrane when one side is in contact with the liquid and the other with ethyl alcohol, and (2) the volume in c.c. of the liquid absorbed by 100 gms. of the membrane :—

	Osmosis.	Absorption.
Water	4,674	121·9
Methyl alcohol	1,748	28·7
Amyl alcohol	646	7·2
Amyl acetate	532	6·8
Chloroform	456	5·5
Benzene	266	5·0
Ether	0	3·2
Ethyl alcohol	—	3·0

T. M. L.

675. *The Exact Relation between Osmotic and Vapour Pressure.* **A. A. Noyes.** (Zeitschr. Phys. Chem. 35. pp. 707–721, Dec. 31, 1900; also Phys. Rev. 12. pp. 84–99, Feb., 1901.)—The osmotic pressure of a solution being defined as the pressure experienced by the semipermeable septum between the solution and the solvent, it is here proved in two different ways that the true thermodynamic relation between the osmotic pressure P_1 and the vapour pressure p_1 of a solution at temperature t is given in general by—

$$\int_{p_1}^{p_0} v\,dp = \int_{p_1-P_1}^{p_0} V\,dP,$$

where V, v are the specific volumes of the solvent and its vapour at temperature t and pressure P, p_0 being the vapour pressure of the solvent. Worthington having shown that the compressibility of a liquid is practically constant even for negative pressures, such as is in general the difference $p_1 - P_1$, this relation reduces to—

$$\int_{p_1}^{p_0} v\,dp = \Pi_1 V_0(1 + \tfrac{1}{2}k_0\Pi_1),$$

where— $$\Pi_1 \equiv P_1 + p_0 - p_1$$

represents what is ordinarily taken as the osmotic pressure (*i.e.*, the total difference in pressure of the solution and solvent when each is under only its own vapour pressure), V_0 the specific volume of the solvent under the pressure p_0 at temperature t, and k_0 the compressibility.

It is also shown that in the general case the relation is complicated, as the osmotic pressure does not depend on temperature only, but also on the *state of compression* of the solution, so that the magnitudes that occur in the relation vary with the condition of the solution, and are not measurable for the solution once for all. R. E. B.

676. *Birotation of d-Glucose.* **Y. Osaka.** (Zeitschr. Phys. Chem. 35. pp. 661–706, Dec. 31, 1900.)—The changes of rotatory power which take place in aqueous solutions of most sugars obey the laws for a reaction of the first order. This is shown to be true in the case of the eight sugars tabulated below, and the velocity constants (at about 20°) have the following values :—

d-Fructose	0·096	*l*-Xylose	0·022
Rhamnose	0·039	*d*-Galactose	0·0102
l-Arabinose	0·031	Maltose	0·0072
Fucose	0·022	Milk-sugar	0·0046

From the observations of Cohen on the effect of d-glucose in diminishing the velocity of saponification of ethyl acetate by caustic soda, it is shown that *d*-glucose is a feeble acid, and that its dissociation constant is $\frac{55{\cdot}5}{0{\cdot}022}$ of that of water ($55{\cdot}5 =$ concentration of water in gramme molecules per litre); taking the value for water as $\frac{1{\cdot}3 \times 10^{-14}}{55{\cdot}5}$, the dissociation constant of glucose is calculated to be $5{\cdot}9 \times 10^{-13}$. The observations of Trey, that the conductivity of an aqueous solution of caustic soda is decreased and that of dilute ammonia is increased by the addition of glucose, can also be explained by assuming that glucose is an acid of the strength described above, and that the salts have a conductivity similar to that of the caproates.

The enormous influence of bases in accelerating the changes of rotatory power is well known, and experiments are described which show that this effect is proportional to the concentration of the hydroxyl-ions. Ammonia alone is too strong a base for experimental purposes, but by mixing it with a known excess of ammonium chloride (which does not directly influence the change) its basic character can be diminished to any desired extent, and the influence of such mixtures on the velocity-constant is proportional to the calculated concentrations of the —OH ions within the limits of experimental error. Experiments are also described in which the following weak bases were used: pyridine, aniline, α-picoline, ethylenediamine, and tri-, tetra- and penta-methylenediamine.

Acids have a much smaller catalytic effect than bases, and here the influence on the velocity constant is proportional to the *square root* of the concentration of the hydrogen ions, as is shown in a very satisfactory way by experiments with HCl and HBr. Neutral salts which accelerate the change in basic solutions do not produce any marked effect in acid solutions, and a mixture of HCl and KCl in molecular proportions gave a constant (0·0184) agreeing closely with the value obtained (0·0186) when only the HCl was present. T. M. L.

677. *Electrostriction of Ions in Organic Solvents.* **G. Carrara** and **M. G. Levi.** (N. Cimento, 12. pp. 284–288, Nov.–Dec., 1900. From the Gazz. Chim. Ital. t. 30. II., 1900.)—An inquiry into the relations between the variations in the molecular volume of a substance in various solvents at various dilutions, and the electrolytic dissociations of the same substance. The question is, in other words, whether these variations depend (Drude and Nernst, Zeit. für Phys. Chem. 15. 79, 1894) on the electrostriction of the solvent by the electrostatic charge of the ions. The molecular volume ϕ (or "equivalent" volume in the case of salts of polyvalent metals) is $A/Q - 1000(s/Q - 1)/m$, where A is the molecular (or equivalent) weight, Q is the corrected density of the solvent at 25°, s is the corrected density of the solution at 25°, and m is the number of molecules (or equivalents) per litre of the solution. The results of a large series of determinations are in accord with the Drude and Nernst theory. The greatest variations in the molecular volumes take place in those electrolytes in which the dissociation, though not great in not very dilute solutions, progresses regularly with the dilution. The investigations are to be continued. A. D.

678. *Electrodeposition of Metallic Lead, and the Formation of Lead Sponge.* **L. Glaser.** (Zeitschr. Elektrochem. 7. pp. 365–369, Dec. 13, and 381–386. Dec. 27, 1900.)—The researches of Foerster and Günther on the electrolysis of zinc chloride solutions [Abstract No. 151 (1899)] have induced the author to make a somewhat similar series of experiments in the case of lead salts. Neutral, acid, and alkaline solutions were examined, and the following conclusions arrived at. Brilliant, coherent deposits of metallic lead may be obtained by the electrolysis of *acid* solutions of lead nitrate or acetate. The formation of spongy lead takes place in feebly acid or neutral solutions, as in the case of zinc, and is to be attributed to the separation of basic salts which are soluble with difficulty and which impede the uniform crystallisation of the metal at the kathode. The formation of lead sponge is prevented by the addition of ammonium persulphate, chlorine, pyrogallol, hydroquinone, &c., *i.e.*, by substances tending to dissolve the basic salts referred to, or to reduce the lead hydroxide. In the case of alkaline solutions good metallic deposits are obtained by the use of a low e.m.f. and vigorous agitation of the electrolyte; otherwise hydrogen is evolved and spongy lead is formed. N. L.

679. *Electrolysis of Fused Salts.* **F. M. Lyte.** (Chem. News, 82. pp. 271–272, Dec. 7, 1900.)—In connection with a recent paper by A. Helfenstein [see Abstract No. 1713 (1900)] on the application of Faraday's law to the electrolysis of some fused metallic salts, the author describes some results obtained several years ago, but hitherto unpublished, in the electrolysis of fused lead chloride. In the experiments referred to, little or no chlorine was evolved, but a small quantity of oxygen was produced, and a cloud of metallic lead appeared to emanate from the kathode and disappear in the neighbourhood of the anode. The phenomenon is considered to be due to the decomposition of lead oxychloride, formed by the action of atmospheric oxygen on the lead chloride, and not to the solution of metallic lead in the lead chloride, as suggested by Helfenstein. N. L.

680. *Efficiency in Manufacture of Calcium Carbide.* **J. B. C. Kershaw.** (Electrician, 46. pp. 164–165, Nov. 23; 245–246, Dec. 7; and 267–268, Dec. 14, 1900.)—The theoretical yields of carbide furnaces calculated by nine authorities are quoted, and it is shown that the great discrepancies are due to the figures being in some cases based upon incorrect data. They range from 1,523 to 3,293 kw. hours per ton of an 80 per cent. carbide, but in the calculation giving the lowest number, no regard was paid to the heat necessary to raise the materials to the reaction-temperature, from 30 to 50 per cent. of the heat-energy required being thus neglected. It is pointed out that the data for these calculations are not known with sufficient certainty to warrant the acceptance of any one figure, but Gin's calculation in *L'Éclair. Élect.* (May 6, 1899) is considered by the author to be the most reliable. Taking the temperature of reaction as 3,300° C., he finds that 212,000 calories are required per gramme molecule of calcium carbide, which is equivalent to an expenditure of 3,887 kw. hours per ton of pure carbide, or of 3,069 kw. hours per ton of the 80 per cent. material.

Seven published statements as to the experimental and estimated number of kw. hours necessary to produce one metric ton (2,204 lbs.) of an 80 per cent. carbide are quoted, and these range from 4,105 to 6,514 (averaging about 4,800). Thirteen similar statements of actual results show a range from 3,576 to 5,960 (averaging nearly 4,500) kw. hours. But of these the following three are regarded as the most reliable and striking: Keller's statement at the Paris Congress (1900) that the latest form of the Gin and Leleux furnace yielded 6·2 kg. of carbide per kw. day (=3,871 kw. hours per ton of 80 per cent. carbide); Carlson's statement in the *Zeits. f. Elektrochemie* (1900) that the continuous furnace yielded 4·5 kg., and the intermittent furnace 5·8 to 6·5 (mean = 6·15) kg. of 76 per cent. carbide per kw. day (= 5,616 and 4,104 kw. hours per ton of 80 per cent. carbide); and Lewes' statement in *Acetylene* (1900) that, at Foyers, the best results have been 3·78 kg. pure carbide per e.h.p. day (= 3,788 kw. hours per ton of 80 per cent. carbide). The three types of furnace used to produce the last-named results are then described, the German type with an illustrative wood-cut. These are: the furnace of the *Deutsche Gold und Silber Scheide Anstalt* (an intermittent type of furnace, with a system of renewing the charge so rapidly that the utilisation of electrical energy is practically continuous, the current values being 2,000–3,000 amperes at 60–65 volts); the Willson Furnace; and the Gin and Leleux furnace. The highest yields yet known have been from intermittent furnaces, and the continuous type is being used chiefly where power is cheap and labour dear. Economy is chiefly to be sought in the utilisation of the waste gases, and in the preparation of the charge, the use of coarser fragments being, probably, of advantage. W. G. M.

681. *Calcium Carbide Plant at Milan.* **V. Lucchini.** (Elettricità, Milan, 19. pp. 758–768, Dec. 1, 1900.)—Power is taken from the Paderno three-phase substation at 3,600 volts, and is transformed to a potential of 34 volts between each phase and the centre by transformers of the capacity of 1,000 kw. A 30-h.p. three-phase motor drives the grinding machines. Calcium carbonate, from Rezzato in Brescia, is burnt in a Hoffmann furnace of a capacity of 4 tons per day; the resulting product contains from 85 to 94 per cent. pure lime. The coke used contains 85 per cent. of carbon. Two grinding machines, with automatic feed, deliver 1,500 kilos of lime and 1,300 kilos of coke per hour. The mixture, in the proportion of 64 to 68 parts of coke to 100 of lime, is taken to a bunker above the furnaces. Four furnaces, by the Compagnie Electro-Métallurgique des Procédés Gin et Leleux, take each 225 kw. at 28 to 33 volts. The bottom of the furnace constitutes one electrode, and consists of two layers, one of low and the other of high resistance; the latter, being heated by the passage of the current, maintains the carbide liquid. The other electrode descends vertically into the centre of the furnace, and is capable of a vertical motion. Three furnaces are worked together, one in each phase of the three-phase supply. Carbide is run out every two hours, when from 115 to 175 kilos are obtained from each furnace; the furnaces are run for 80 hours, each yielding a block of carbide weighing from 1,100 to 1,850 kilos. Their production is 5·6 kilos per kw. day. The electrodes last about 150 hours; they are of graphite, or a mixture of graphite and anthracite, and are heated for ten hours at 1,200° C. before use. The furnace gases are drawn off by a ventilator. The carbide blocks are broken up into pieces of about two cubic decimetres, which are then treated by a crusher; a sorter then separates the crushed ore into five different sizes, for packing in tins holding from 2 to 25 kilos. The carbide yields from 300 to 312 litres of acetylene per kilo. G. H. B.

682. *Manufacture of Ferro-Titanium at Niagara.* **O. E. Dunlap.** (Elect. Rev. 48. pp. 99–100, Jan. 18, 1901.)—The author states that of the iron ore available in the United States at least 30 per cent. is unfitted for use, owing to its percentage of titanium. A process has been investigated for successfully treating this titaniferous iron; and it is therefore apparent that if this ore can be easily smelted, the country's wealth will make material advancement. At the present time about 500 lbs. of the new alloy, ferro-titanium, are turned out every twenty-four hours at Niagara. Through large furnaces containing scrap-iron, titaniferous ore, and small blocks of aluminium, a powerful current is sent. The result of the reduction is pure oxide of aluminium, ferro-titanium (which is formed into cakes), and a slag that is valuable. O. J. S.

683. *Anodes for Electrolytic Alkali Cells.* **A. T. Weightman.** (Ind. Électrochim. 4. pp. 94–96, Oct., 1900. From the Engineering and Mining Journal, Aug. 4, 1900.)—The essential characteristics of good anodes are high conductivity and durability. Only a few substances possess these in the required degree. Lithanode (peroxide of lead), patented by Fitzgerald in 1890, failed because it was attacked by hydrochloric acid. Hoepfner, Liveing, and Parker & Robinson have patented the use of other compounds for anodes, but none of these have been very successful.

Carbon, when used as an anode in the cell, is not attacked by the chlorine, but by the oxygen and oxy-chlorine compounds which in most cases accompany it. This disadvantage is met by Richardson and Holland, and by Connor, by reducing the first cost of fresh carbon anodes. These inventors use rough blocks of gas-carbon and build up anodes of any size and form by the use of lead and cement. Other inventors have sought to minimise the liberation of oxygen and its compounds in the anode chamber of the cell by improved construction.

The influence of current density and of temperature upon the life of the carbon anodes is not sufficiently recognised. The disintegration is more rapid the higher these are maintained. Graphitized carbon is less attacked than ordinary carbon, and at Widnes and Niagara the Castner cell was originally worked with anodes made by Castner's own process. This consisted in heating ordinary carbons in an electric furnace to a white heat, the carbons being embedded in carbon dust during the heating and until cold. Most of the electrolytic alkali works now use graphitized carbons manufactured under Acheson's patents at Niagara. This process depends upon the decomposition of metallic carbides at the temperature of the electric furnace. In order to test the durability of samples of various carbons, it is best to submit them to a ten hours' laboratory trial in a 10 per cent. solution of sulphuric acid, and to determine their loss in weight.

The article closes with a reference to the use of platinum and its alloys, and to the various patented devices for securing large surface area of this metal at a low cost. One of the best of these is that devised by Le Sueur and in use at Rumford Falls. Short lengths of platinum wire are bunched together in glass tubes, and electrical connection is obtained by pouring in a small quantity of mercury. Such anodes cost only about 75 cents each and are highly efficient. J. B. C. K.

684. *Carbon Electrodes.* **F. Winteler.** (Zeitschr. Elektrochem. 7. pp. 356–359, Dec. 6, 1900.)—For use in the electrolysis of chloride solutions carbon anodes should satisfy three conditions: (1) The proportion of hydrocarbon should be small—a result which can only be secured by prolonged burning of moulded rods of gas-carbon mixed with tar or pitch; (2) the gas must be liberated as much as possible at the surface of the electrode, and the current density should therefore not exceed 2 amperes per sq. dcm.; (3) the carbon must not contain soluble impurities, and the fact that gas-carbon contains little but insoluble silicates of aluminium and iron renders it specially good in this respect. Carbon electrodes, however, very soon perish if oxygen is liberated at the anodes, and the presence of, for example, sodium sulphate as an impurity in the electrolysis of salt solutions greatly shortens the life of the carbons.

In the manufacture of aluminium the presence of hydrocarbons in the carbon of the electrode is of no importance; the chief essential is that the electrodes should be free from silica and silicates, since otherwise silicon fluoride is formed by the action of the fluorine, causing a loss of fluorine from the bath; another danger is the reduction of the silica to silicon by the aluminium at the bottom of the bath, which would cause a waste of aluminium and render the metal impure. The best carbon for this purpose is an ash-free carbon such as is formed in making oil-gas by "cracking" petroleum oils.

For carbide manufacture the presence of hydrocarbons and of silica is of no importance, and the chief essential is that phosphates should be absent, as otherwise calcium phosphide is produced, and the acetylene is contaminated with phosphoretted hydrogen. T. M. L.

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685. *Chemical Activity of the Silent Discharge.* **Berthelot.** (Comptes Rendus, 131. pp. 772–781, Nov. 12, 1900.)—This paper treats of the chemical reactions produced in gases by the various forms of silent electric discharge [see further Abstract No. 533 (1898)]. T. H. P.

686. *Solubility of Alkali Chlorides in Caustic Alkalis.* **F. Winteler.** (Zeitschr. Elektrochem. 7. pp. 360–362, Dec. 6, 1900.)—A knowledge of the solubilities of the chlorides and chlorates of the alkali metals in solutions of the hydroxides of the latter is of importance in connection with the treatment of the liquids obtained in the electrolytic preparation of caustic alkalis, &c. The author has therefore determined, and recorded in tabular form, the solubilities at 20° C. of potassium chloride in solutions of caustic potash of various strengths, of potassium chlorate in potassium chloride solutions, of sodium chloride in caustic soda, and of sodium chlorate in sodium chloride. The specific gravities of the solutions are also given. N. L.

687. *Electric Furnaces.* **Keller.** (Écl. Électr. 24. pp. 312–320, Aug. 25, 1900. Paper read before the International Electric Congress at Paris. Abstract in the Electrician, Sept. 28, 1900.)—A classification of the various types of furnace, and a summarised account of the more important of them, with a note as to electrodes, current conditions, and a brief sketch of the development of the industries employing the electric furnace. W. G. M.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

688. *Delaunay-Belleville's High-speed Engine.* **M. Aliamet.** (Électricien, 20. pp. 51–56, July 28; 121–125, Aug. 25, 1900.)—High-speed engines have been very largely developed of late years for the purpose of driving dynamos, and though from a theoretical point of view high speeds are advantageous, from a practical point of view they introduce several difficulties. The lubrication is no longer a simple matter. Rubbing surfaces wear more quickly, and, if they are not carefully watched, knocking is the inevitable result. This has led to the use of high-speed single-acting engines. High-speed engines consume more steam than slower-running engines of the same power. The principal reasons for this increased steam consumption are as follows: increased clearances which have to be filled at each stroke, and the impossibility of using valves permitting of a high ratio of expansion in the cylinders. The cylinders of the Delaunay-Belleville engine are placed in tandem. The valves are piston valves and driven off one eccentric.

The 75-h.p. engine has the following dimensions:—

H.P. cylinders	7·48 inches diam.
L.P. „	11·81 „ „
Stroke	9·84 „
Cylinder ratio	2·55
Revolutions per minute	360
Initial pressure	120 lbs. per square inch.

The oil pump of this engine is valveless and is worked on the "oscillating-cylinder principle" off the end of the crank-shaft by a small crank. The oscillations of the pump are made to open and close the ports. The pump forces the oil into a reservoir under pressure. This is fitted with a safety valve to keep the pressure from rising too high, and a steam coil runs through it to keep the oil thoroughly fluid.

Careful provision is made for cleaning out the various oil passages, should any of them become blocked. The pistons and valves are greased by the use of "Valvoline" in the steam in the usual way. The governor is of the ordinary ball type, working a butterfly or a double-beat valve.

A series of trials was carried out under the supervision of Compère, chief engineer to the Paris Steam Users Association. The engines exhausted into a separate condenser from which the water was carefully measured, and each engine was tested, both condensing and non-condensing. Cards were taken every quarter of an hour. When working with a vacuum the initial pressure was 114 lbs. per square inch, and with no vacuum it was raised to 143 lbs. per square inch, to keep the h.p. the same. Cut-off was at about 50 per cent. The results of the trial show a good steam consumption and a high mechanical efficiency, due, no doubt, to the excellent oiling arrangements. The results of the tests go to show that as the number of cylinders increases, the mechanical efficiency decreases, and that it is useless to increase the number of expansions without also increasing the initial pressure.

The following table gives the principal results obtained by Compère;

but it should be noted that in two instances the imperfect working of the indicators has given too high readings of the power.

	Compound Engine.		Triple Expansion.		Quadruple Expansion.	
	Condensing.	Non-condensing.	Condensing.	Non-condensing.	Condensing.	Non-condensing.
Duration of trial ...	2 hrs.	2 hrs.	1 hr. 30 mins.	1 hr.	2 hrs.	2 hrs.
Initial pressure lbs.	114	143	194	194	232	232
Revs. per min.......	366	363	360	360	360	360
Horse-power	h.p. 39·38 l.p. 43·69	h.p. 41·56 l.p 42·83	h.p. 99·16 m.p. 96·25 l.p. 95·85	h.p. 99·03 m.p. 92·73 l.p. 59·37	h p. No. 1 26·55 m.p. { No. 2 29·84 m.p. { No. 3 28·45 l.p. No. 4 30·76	h.p. No. 1 25·50 m.p. { No. 2 28·11 m.p. { No. 3 26·88 l.p. No. 4 13·07
Total h.p.	83·07	84·39	291·26 [1]	247·13	115·60	93·56
Brake h.p.	79·16	78·50	295·6	225·4	112·29	83·04
Steam per i.h.p. in lbs.	19·33	22·38	—	18·06	15·24 ?	19·22
" " b.h.p. "	20·30	24·06	15·98	19·80	15·69 ?	21·90
Mech. efficiency ...	95 per cent.	93 per cent.	—	91 per cent.	97 per cent. ?	89 per cent.

[1] This figure is incorrect.

L. S. R.

689. *Steam Turbines.* (Railroad Gazette, 32. pp. 857–860, Dec. 28, 1900. Extracts from a paper by **F. Hodgkinson** read before the Engineers' Society of Western Pennsylvania, Nov. 20, 1900. Also Elect. Rev. N.Y., Dec. 26, 1900, and Jan. 5, 1901.)—Descriptions of the Laval and Parsons turbines are given with very clear diagrams and illustrations; also a method of measuring the pressure at any point in a Laval steam nozzle by means of a small exploring tube attached to a pressure gauge. A test of a Laval turbine working at 307·8 h.p. gave 13·92 lbs. of steam per h.p. hour, steam being at 192 lbs. and superheated 69° F. A Parsons turbine working at 1,200 kw. has run for 14·03 lbs. per e.h.p. hour = 11·9 lbs. per i.h.p. hour [see Abstract No. 1135 (1900)]. As an example of the actual force on the blades, it is stated that in a 300-kw. Parsons turbine in which there were 16,095 moving blades, the forces exerted varied from 0·89 to 1·04 ounces per blade. H. R. C.

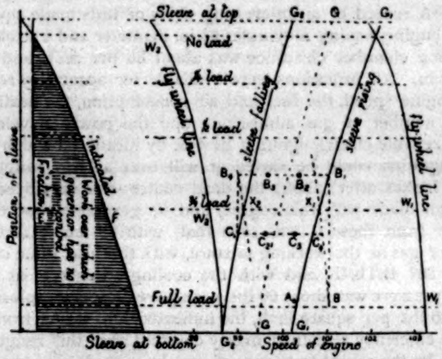
690. *Ellis and Eaves' Induced Draught.* (Mech. Eng. 6. pp. 847–849, Dec. 15, 1900.)—The various systems of mechanical draught are well known. In this paper attention is redirected to the advantages of the "induced" draught system as worked out by Ellis and Eaves, and applied to marine and land installations—those specially quoted being that of the ss. *Inchkeith* and the marine-type boilers at the Sheffield Electric Light and Traction Stations.

The air superheater, now fitted in conjunction with Ellis and Eaves' apparatus, is an efficient one, as it is possible to heat the air to over 300° F. by its means. Valves or dampers are provided to switch off any furnace from the fan suction and thus prevent the inrush of cold air from the stokehold when the fire-doors are opened. F. J. R.

691. *Tests of Speed Variation by Tuning-Forks.* **F. Göpel.** (Zeitschr. Vereines Deutsch. Ing. 44. pp. 1359–1368, Oct. 6, and 1481–1485, Oct. 20, 1900. Communicated by the Physikalisch-Technische Reichsanstalt.) —A brass disc is placed on the end of the rotating shaft, and a vibrating

tuning-fork is made to trace a sinuous spiral curve on its smoked surface. From this curve can be found the degree of uniformity of speed through one or more revolutions. Electromagnetic tuning-forks were not used on account of the inconstancy of their frequency. For speeds between 70 and 800 r.p.m. a fork with a periodicity of 435 per second was found to be suitable in every respect. A full exposition is given of the method used in analysing the results. In the case of a 80-h.p. gas dynamo with a load of 7·2 h.p., the speed variation in the cycle of two revolutions was 0·86 per cent. [No particulars are given of the flywheel.] With a load of 4 h.p. the variation was 0·56 per cent. A steam dynamo of 35 h.p., with a load of 28 h.p., gave variations of 3·5 per cent. and 1·2 per cent. respectively at different times. A few other results are quoted, and some curves are given showing the angular speed for various positions of the crank through one or more strokes. W. H. E.

692. *Flywheels.* **A. Sharp.** (Mech. Eng. 6. pp. 628–631, Nov. 3, 1900, and 660–663, Nov. 10, 1900. Paper read before the Manchester Association of Engineers, Oct. 27, 1900.)—After an investigation of the variation of crank effort and illustrations of the coefficients of fluctuation of energy for various types of engine with calculation of the flywheel energy required, the author illustrates on a single diagram the combined effects of flywheel and governor.



The co-ordinates are speed of engine and position of governor sleeve. The subsidiary diagram on the left gives as abscissæ the work capable of being done by steam which has already been admitted to the engine, this being, of course, greatest when the governor is down and full steam admitted. The line G G is the characteristic of the governor, and, allowing for friction, $G_1 G_1$ gives the relation between speed and position when rising, $G_2 G_2$ when falling. If the conditions are as represented at X_1 and the whole load is thrown off the engine, then the amount of work E F may be expended in increasing the speed to W_1; $X_1 W_1$ being inversely proportional to the mean energy of the flywheel. In this way, from the data of the engine, the flywheel lines $W_1 W_1$ and $W_2 W_2$ are plotted. To examine the combined effect of governor and flywheel, suppose, for instance, that the engine had been running at full load, one-quarter of which is suddenly removed; the increase of speed may be the difference between $A_0 W_1$ and $X_1 W_1$; this is set off as A B and $B B_1$ drawn vertically; the governor would rise to B_1. This corresponds to a smaller load than that on the engine, and the speed falls, being represented at the end of successive strokes by $B_2 B_3$, &c. When the speed falls outside $G_2 G_3$, as at B_4, the governor would fall to C_1 and the speed gradually rise through $C_2 C_3$; the cycle being repeated on a smaller scale, *i.e.*, starting now from C_4 instead of B. If the flywheel is not sufficiently powerful, so that the flywheel line is less steep than the governor line, the governor will hunt persistently. If the flywheel line is vertical the engine will most quickly settle down to its new speed after a change of load; while if the flywheel is still more powerful, so that the line slopes in the same direction as the governor lines, the engine will quickly approach its new speed and not overshoot it.

An examination of the stresses set up in the rim and arms of a rotating flywheel follows, and is accompanied by illustrations of various types of design, including one by the author, in which the cast-iron rim is connected to the boss by numerous tangent spokes. H. R. C.

GAS AND OIL ENGINES.

693. *Heat Efficiency of a Gas Engine as Modified by Time of Ignition.* **C. V. Kerr.** (Horseless Age, 7. pp. 29–31, Dec. 12, 1900. Abstract of a paper read before the American Society of Mechanical Engineers, N.Y., Dec., 1900.)—A record of an interesting series of tests made upon a single-cylinder gas engine, having a cylinder 6¾ in. diameter and a stroke of 12 in.; the combustion chamber clearance was about 35 per cent., and the normal speed 240 r.p.m. All provisions were available for accurately recording the b.h.p., the engine speed, the fuel and air consumption, the heating value of the gas, the number of gas admissions, and the power developed in the cylinder. A reliable electric-ignition device, by means of which the precise moment of ignition could be varied at will over a large range (4½ inches before to 4½ inches after) about the dead centre, was employed. Previous tests had been made with this engine, and its general characteristics were well known; from these it was seen that, with 6·6 cubic feet of air and 1 cubic foot of gas as the working mixture, with the heat value of the gas at from 811 to 867 B.Th.U., and with the cooling-water kept at 160° F., the compression pressure was about 60 lbs. per square inch, the explosion pressure was about 240 lbs. per square inch, the indicated h.p. varied from 3·8 to 11, and the heat efficiency remained nearly constant over this range of load at 22 per cent. In the recent tests runs of one hour each were made with the igniter set to various positions, and three different loads were experimented with—no-load, 2·5 b.h.p., and 5 b.h.p. For each load the point of ignition was made as early and as late as would enable the engine to continue running at normal speed. A hit-and-miss governor was used. Indicator cards were taken at frequent intervals, and the general results obtained showed the following further characteristic features of this particular engine under the special conditions imposed: On no-load, ignition was varied from $+ 4\frac{19}{32}$ inches (before the end of the compression stroke) to $-$ 2 inches (after the dead centre); the highest heat efficiency was at + ½ inch, the highest explosion pressure was at an earlier ignition-point, the terminal compression varied from 55 to 65 lbs. per square inch, and the pressure released varied between 29 and 54 lbs. per square inch. With a load of 2·5 b.h.p. the highest efficiency was obtained at + ½ inch and the maximum explosion pressure at + 2½ inches. With the 5-b.h.p. load the maximum efficiency was at dead-centre ignition and the highest explosion pressure at + 2½ inches, but so wide a range of ignition could not be secured at this load, and no runs with any greater load were therefore attempted. Mechanical efficiency was found to increase slightly with later ignition. It was shown that ignition should never occur later than the dead centre so far as heat efficiency is concerned. The interval between ignition and maximum pressure was almost constant (0·08 sec.), for ignition before dead centre, but this interval increased decidedly with later firing-points. A summary of these tests is given in the following table :—

Point of Ignition. Inches.	Length of Run. Minutes.	Cubic Feet Gas per Hour.	Explosions per Minute.	Engine Speed r.p.m.	Horse-Power.		Average Friction h.p.	B.Th.U. in Gas.	Heat Efficiency.	
					Indicated.	Brake.			In Cylinder.	At Brake.
$+4\frac{19}{32}$	60	65·72	44·3	238	2·63	0	2·56	893	0·114	0
+2½	30	54·24	34·6	,,	2·82	0		,,	0·148	0
+1½	60	43·52	27·3	,,	2·68	0		,,	0·172	0
+ ½	60	40 08	25·0	,,	2·63	0		,,	0·187	0
±0	60	40·47	25·0	,,	2·31	0		,,	0·163	0
− ½	60	65·83	41·1	,,	2·83	0		,,	0·123	0
−1	60	74·45	50·3	,,	2·54	0		,,	0·097	0
−1½	40	85·02	54·4	,,	2·41	0		,,	0·081	0
−2	60	115·26	83·7	,,	2·21	0		,,	0·055	0
+4½	60	106·82	79·2	,,	5·08	2·5	2·08	938·5	0·128	0·063
+2½	60	83·23	56·7	,,	4·73	,,		899·2	0·160	0·085
+1½	60	71·95	50·1	,,	4·67	,,		938·5	0·176	0·095
+ ½	60	71·50	47·3	,,	4·78	,,		899·5	0·186	0·098
±0	60	66·75	45·0	,,	4·44	,,		938·5	0·181	0·102
− ½	60	97·18	68·6	,,	4·35	,,		977·0	0·116	0·067
−1	60	118·42	86·7	,,	4·14	,,		955·0	0·093	0·056
−1½	60	147·6	109·3	,,	4·47	,,		955·0	0·081	0 045
+2½	60	131·78	96·7	,,	7.96	5·0	2·31	899	0·171	0·108
+1½	60	120·44	88·8	,,	7.46	,,		,,	0·175	0·118
+ ½	60	108·21	75·6	,,	7.24	,,		,,	0·189	0·130
±0	60	105·25	82·0	,,	7.33	,,		,,	0·197	0·134
− ¼	60	159·73	108·6	,,	6.56	,,		,,	0·107	0·082

A. G. N.

694. *Tests of Benzine Motors.* **H. Güldner.** (Zeitschr. Vereines Deutsch. Ing. 44. pp. 1320–1324, Sept. 29 ; and 1728–1732, Dec. 15, 1900.)—This paper describes tests made by the author on two car-motors by Henile and Wegelin and one by the Aachen Stahlwaren-Fabrik. The means employed to measure the b.h.p. and the i.h.p. are fully described, and numerous indicator diagrams are reproduced. The following are the results obtained :—

Henile and Wegelin motor : Single cylinder ; radiation-cooling ; electric ignition ; speed, 650 r.p.m. ; two-speed ratios, 1 : 2·4 and 1 : 5·0. B.h.p. at 712 r.p.m., 2·71. B.h.p. at 650 r.p.m., 2·47. Benzine consumption per b.h.p. hour at full-load, 0·721 kg. Mechanical efficiency at low-speed ratio, 0·774 ; at high-speed ratio, 0·709.

Aachen Stahlwaren-Fabrik motor : Single-cylinder ; water-cooling ; electric ignition; spray carburettor; speed, 1,400–1,500 r.p.m.; two-speed ratios, 1 : 6 and 1 : 14. B.h.p. at 1,485 r.p.m. 2·87. Benzine consumption per b.h.p. hour, 0·807 kg. Mechanical efficiency at low-speed ratio, 0·80. G. H. B.

695. *Compound Explosion Engines.* **C. P. Malcolm.** (Horseless Age, 7. pp. 14–15, Dec. 5, 1900.)—After giving the following advantages which would be gained by a compound construction for automobile oil motors—silence of exhaust, increase of power, and greater uniformity of turning moment—the author proceeds to describe a simple form of arrangement in which a low-pressure cylinder is placed between two alternately acting cylinders of the usual "Otto" cycle type. In this engine the explosion cylinders work upon cranks which are set opposite to, and on the same crank-shaft as, a central crank; the low-pressure cylinder is connected to this central crank. All three pistons have the same length of stroke, but the area of the low-pressure cylinder is three times that of each of the other cylinders. Each explosion cylinder exhausts direct into the central cylinder through a valve, and the expanded gases pass from this latter cylinder to the atmosphere, during each inward stroke of its piston, through another valve. A pair of inwardly opening suction valves are also fitted in the head of the low-pressure cylinder in order to allow air to enter, in the event of either explosion cylinder missing fire. The writer assumes that the pressure of the exhaust gases acting upon the low-pressure piston is about 45 lbs. per square inch, and that they expand during the working stroke of this cylinder to atmospheric pressure. It is pointed out that this system is by no means new—in the seventies or early eighties such a motor was patented—but that valve construction and mechanical details have been too faulty to ensure success hitherto. The author incidentally, but strongly, condemns the use of poppet valves for all gasoline motors, and advocates the employment of water-jacketed and balanced piston valves. A. G. N.

AUTOMOBILISM.[1]

696. *Brolliet Motor.* **J. M. Hertrich.** (Locomotion Automobile, 7. pp. 804–805, Dec. 13, 1900.)—A description with a diagrammatic drawing of a motor in which two parallel cylinders are fitted with double pistons. Four combustion chambers are formed by the closed ends of the two cylinders. A rocking arm is connected to both pistons, and it passes through slots in the cylinder walls. Tubes pass through the centre of the pistons and the cylinders from end to end, and water is circulated through these instead of being led into outside jackets. A. G. N.

697. *The Legrand Car.* (Locomotion Automobile, 7. pp. 802–804, Dec. 13, 1900.)—This vehicle, which weighs about 14 cwt., and is fitted with springs between the underframe and the axles, has several interesting features. The body is mounted upon a separate set of springs, between it and the underframe. The steering pillar and wheel are fixed to the body, and they actuate the front wheels through a flexible connecting system. Two entirely distinct 3-h.p. De Dion motors are fitted, one on each side of the underframe; they are placed low down and at about the centre of the car longitudinally. Each motor is provided with a wood pulley upon its crank-shaft, and the power is transmitted from them both to the two extremities of a toothed-wheel change-speed-gear shaft by means of leather belts. Loose pulleys are mounted upon

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[1] Electric Automobiles are described in the section dealing with Electric Traction.

independent idle shafts in such a way that they face the fixed pulleys on the gear shaft. A common striking gear enables the driver to throw the two belts from the loose to the fixed pulleys. It has been found that whatever the relative positions of the two pistons may be when starting the motors, they always fall into synchronism after starting, and it is said that the vibration caused by either motor separately is largely cancelled by the operation of the other. A single chain transmits the power from the gearing to a differential gear upon the rear axle. Water cooling is used for the cylinders, and this is circulated through a radiator by a pump in the usual manner. Each motor has its own carburettor and electric ignition device, but the timing regulator with which the driver controls the latter is common to both motors. The illustrations accompanying the description show the general form and arrangement of the chief parts. A. G. N.

698. *Vinet Motor Car.* **P. Sarrey.** (Locomotion Automobile, 7. pp. 818–820, Dec. 20, 1900.)—The author describes a light petrol car, of neat design and appearance, for seating two persons. It is propelled by a de Dion and Bouton engine of 3½ h.p. or of 5 h.p. mounted at the front of a tubular underframe, and covered by a bonnet, the front of which is cut away to fit the coils of the radiator for cooling the jacket-water of the engine. The underframe is sprung from the front axle by the usual plate springs, and is bent down to the level of the live rear axle, the enclosing tube of which forms the back member of the frame. The carriage body is independently sprung from the tubular frame by scroll plate springs at the back, and is pivoted upon it in front. The power is transmitted from the engine first by a spur gear to a short shaft carrying a belt pulley, and thence by an equal belt drive to a counter-shaft at the back of, and level with, the driving axle. Three spur pinions are mounted on this shaft, and these may be brought into engagement, by side contact, with corresponding spur wheels mounted on the exterior of the differential gear on the driving axle, and forward speeds of 5, 15, and 26 miles per hour obtained. By means of an intermediate pinion introduced between one pair of the forward driving pinions and the wheels when these are out of engagement, a reverse motion may be imparted to the car. The belt drive is controlled by a jockey pulley operated by a pedal, so that the power may be applied to or cut off from the driving gear as desired. The controlling levers for the engine and carburettor are mounted upon the steering pillar, and those for the change-speed gear, reverse, and brakes are at the driver's left hand, his right hand being, contrary to the usual practice, always upon the steering wheel, and his seat at the left-hand side facing the forward direction. The article is illustrated by two photographs and plan and elevation drawings. C. R. D'E.

REFERENCE.

699. *Brakes for Automobiles.* **M. L. Bochet.** (Horseless Age, 7. pp. 23–25, Nov. 21, 1900. Report presented to the International Automobile Congress.)—The author considers the employment of the motor itself for retarding or reducing the speed of automobiles, and he deals separately with cars propelled by each of the three well-known systems—steam, oil, and electricity. He states that this method of braking is to be preferred, and he then proceeds to consider the various types of mechanical brakes now in use: shoe brakes and band brakes. After mentioning the different devices which are generally fitted by builders of these vehicles, and after referring to the French regulations concerning this subject, he concludes with a consideration of the various means employed for preventing automobiles from running backwards down hills. A. G. N.

GENERAL ELECTRICAL ENGINEERING.

700. *Phénix Accumulator.* **J. Reyval.** (Écl. Électr. 25. pp. 454–456, Dec. 22, 1900.)—This article only deals with the construction of the electrodes used in the latest type of cell. Each consists of a positive and negative made up together by packing lead peroxide round a central lead rod within a porous-ware tube, and surrounding it externally with a layer of spongy lead in which is embedded a lead wire wrapped spirally about the tube. An outer casing of thin sheet lead perforated with a large number of small holes is provided. The complete composite electrode weighs about 650 gms., and is 230 mm. high by 35 mm. in diameter. E. J. W.

701. *Lee-Coll Accumulator.* (Automotor Journal, 5. pp. 112–114, Dec., 1900.)—The positives of this cell consist of a number of porous-ware tubes containing lead peroxide packed round a central conducting core of lead. The negatives are sheets of fine copper gauze bent and shaped so as to encircle each positive. The electrolyte contains sulphates of zinc and cadmium, from which these metals are deposited at the negatives on charging. Some curves are given to illustrate certain peculiarities in the discharge of the cells. E. J. W.

702. *Estimation of the Size of Accumulator Batteries.* **E. Suchy.** (Zeitschr. Elektrotechn., Wien, 18. pp. 609–610, Dec. 16, 1900.)—A method of calculation is given for the necessary size of a battery to provide for a demand which follows a certain load curve. It is assumed that within practical limits the increase of capacity with the time of discharge follows the linear law $C_n = a(1 + bT_n)$, in which C_n is the capacity for a discharge lasting T_n hours, and a and b are constants. The value of b for batteries of usual construction is 0·06. The formula,

$$a = \frac{t\Sigma i}{1 + ntb}$$

is then simply deduced, t being the length of a time interval into which the whole period may be divided, and Σi the sum of the currents throughout these intervals. The method is illustrated by the following simple example. A battery has to provide 50 amperes for two hours, then 100 amperes for one hour, and finally 30 amperes for 5 hours. Here—

$$a = \frac{1 \times (50 + 50 + 100 + 30 + 30 + 30 + 30 + 30)}{1 + (8 \times 1 \times 0{\cdot}06)} = 237$$

Hence for a three-hour discharge battery, the necessary capacity is given by

$$C_n = 237(1 + 0{\cdot}06 \times 3) = 280 \text{ ampere-hours,}$$

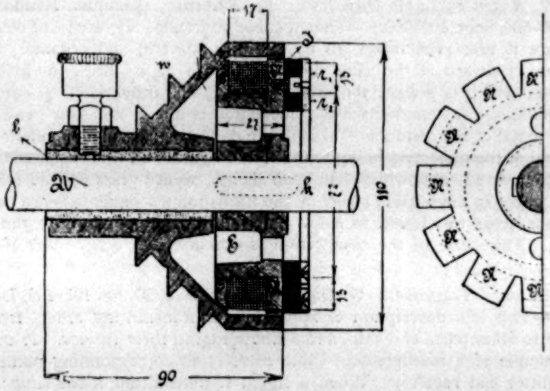
and for a five-hour,

$$C_n = 237(1 + 0{\cdot}06 \times 5) = 308 \text{ ampere-hours.}$$

W. W. H. G.

703. *Wilste and Rupprecht's Accumulator Switch.* **E. Dick.** (Zeitschr. Elektrotechn., Wien, 18. pp. 537–540, Nov. 4, 1900.)—This apparatus comprises a vertically arranged solenoid having five coils, of which two are connected in the armature circuit of the dynamo, and two or all of the others are connected as a shunt to the armature. In the interior of the solenoid works an iron armature core suspended from one arm of a pivoted balance beam, from the other arm of which is suspended a vertical bar; the core and bar bear at their lower ends a series of bridge-pieces adapted to dip into correspondingly arranged mercury cups when the armature core is raised or depressed. The system is normally held with the bridge-pieces out of the cups by means of two spring-pressed arms acting on opposite sides of a roller on the vertical bar. When the pressure at the dynamo terminals reaches a predetermined value, the bridge-pieces are moved up or down to complete the armature circuit, whereupon the series coils on the solenoid are energised and the contact thus made secure. The apparatus is adapted for use in connection with Dick's system of railway train-lighting. (See Elektrotechn. Zeitschr. 1898, Heft 17; and Zeitschr. f. Elektrotech. 1899, Heft 12 and 13.) The paper is illustrated by diagrams and photographs. C. K. F.

704. *Electromagnetic Clutch.* **J. Löwy.** (Zeitschr. Elektrotechn., Wien, 18. pp. 623–624, Dec. 23, 1900.)—This simple form of electromagnetic clutch is in use for driving light lathes in the k.k. Staatsgewerbe Schule at Vienna, and comprises an annular electro-magnet E keyed on to the driving shaft W and supplied with current through brushes sliding on insulated contact-rings $r_1 r_2$. Each polar flange of the channel-shaped core is divided into teeth as shown. The magnet E fits into the stepped cone *w*, from which the lathe is driven, the cone *w* being capable of turning freely on the shaft W, except when the magnet E is energised. The magnet is wound to 430 ohms, and takes 0·2 ampere at 85 volts. C. K. F.



705. *High-Tension Switch.* **J. Froitzheim.** (Elektrotechn. Zeitschr. 21. pp. 977–979, Nov. 22, 1900.)—This paper describes a switch gear for use with the Helios three-phase generator at the Paris Exhibition. A cast-iron column bears a dial with eight instruments, and before this stands a second small column, with central wheel actuating the main switch, and side ratchet levers for adjusting the generator's and its exciter's field resistances. The three-phase high-tension switch is placed below the floor, carrying the switch-column, and besides being actuated by hand is provided with an automatic device to open the switch in case of excess of current. Its novelty consists in the application of an air-blast to blow out the arc on breaking contact. Air is supplied at a pressure of 20 atmospheres by a pump worked by a three-phase motor, which is automatically switched on and off by a piston acted on by the air pressure and controlled by a spring. G. H. B.

706. *Water Resistance.* **W. E. Warrilow.** (Elect. Rev. 47. pp. 1011–1012, Dec. 28, 1900.)—The author discusses the use of large units in electrical power stations, and describes with illustrations a cheap and effective water resistance for large powers. An iron tank is used, 8ft. × 4ft. × 3ft. 3in. deep, with water supply laid on; one electrode consists of strips of lead carried on wooden beams, while the tank is used for the other. The beams are raised and lowered by a wire rope, insulated from them, and led over pulleys into the engine-room, where it is attached to a screw gear, by means of which the resistance is adjusted. A pointer moving over a scale indicates roughly the value of the resistance. The resistance is fixed on the roof of the station, and has carried 600 kw. successfully with the electrode only one-quarter immersed, the water being kept running all the time. The total cost was about £30, exclusive of cables. A. H. A.

707. *Action in Cable Dielectrics.* **G. Rheins.** (Comptes Rendus, 131. pp. 505–506, Sept. 10, 1900.)—When a cable undergoes alterations of electrical pressure it preserves intact all its qualities, electric and organic. If the pressure is always in the same direction it loses its qualities one by one in an order which is always the same, viz.: (1) Self-induction; (2) capacity; (3) insulation; (4) conductivity. This action is due to the slow penetration of the metal of the conductor through the dielectric: it is independent of the material of the dielectric, being found in both gutta and (impregnated) paper. A gutta-covered cable which has been in use twenty years will be found to have copper in the outside layers of the insulation; a paper-covered cable in use four years was found to show penetration of copper only to the inner layers. The cause of the penetration is obscure. M. O.'G.

708. *Ships' Telegraphs.* **G. Dary.** (Électricien, 20. pp. 401–406, Dec. 29, 1900.)—This is a description of apparatus for transmitting orders from the bridge to other parts of a ship, and acknowledging their receipt. It consists in principle of a multiple-core cable connecting corresponding points of a transmitter and receiver. When a signal is transmitted, a bell rings, and a lamp is lighted at the corresponding points of both instruments, while upon repeating the signal at the receiver the bells are stopped and the lamps extinguished, thus indicating that the order has been received. The receiver may be mechanically connected with the machinery to which the order refers, so that upon carrying out the order the signal is automatically repeated at the transmitter. A speed annunciator and a rudder telegraph of similar type are also described. It is suggested that as the cessation of the indication due to an interruption of the line could not be distinguished from the acknowledgment signal, it would be better to perform the function of the latter by causing the bell to ring instead of by stopping it. The apparatus has been fitted on several French warships and merchant steamers.

A. H. A.

GENERATORS, MOTORS, AND TRANSFORMERS.

709. *Effect of Wave-Shape on Core Loss in Transformers.* **G. Benischke.** (Elektrotechn. Zeitschr. 22. pp. 52–57, Jan. 17, 1901.)—It is usual to assume that the total iron loss may be represented by means of the formula—

$$\mathrm{L} = \eta n \mathrm{B}^{1 \cdot 6} + \beta n^2 \mathrm{B}^2 \qquad (1)$$

in which n is the frequency, B the maximum induction, and η and β two constants. It has been known for some time that η is not quite constant, but varies with B. Now if we assume that B is maintained constant, but that the frequency and the wave-shape are varied, then there arises the further question as to whether η and β also vary with frequency and wave-shape. The author's elaborate research deals with this problem. Three widely different wave-shapes, which we may call I, II, and III, were used. These were all obtained from the same three-phase generator, by varying the coupling of the three phases. Wave I was that corresponding to a single phase, and was highly peaked, as the following harmonic analysis shows:—

$$e_1 = 61 \cdot 6 \sin pt - 17 \sin 3pt - 0 \cdot 87 \sin 5pt - 1 \cdot 06 \sin 7pt + 1 \cdot 06 \sin 9pt.$$

Wave II, which corresponded to that between two terminals of the machine, the phases being coupled star fashion, was practically a pure sine wave; while wave III, obtained by reversing the connections of one of the phases between the terminals used, was a flat-topped wave with two well-marked humps—

$$e_3 = 62 \cdot 9 \sin pt + 31 \cdot 1 \sin 3pt.$$

The harmonic analysis of the waves afforded a means of determining their amplitude factors (ratio of r.m.s. to maximum value). Further, an integration of the waves gave a means of finding the corresponding waves of magnetic induction, and their amplitude factors; from which the r.m.s. values of the p.d. corresponding to the same value of B for each of the three waves could be found. The ring experimented on consisted of discs 0·5 mm. thick, having an external diameter of 30 cm., and an internal diameter of 24 cm. The cross section of the ring was 8·85 sq. cm., and it was uniformly wound over with 300 turns. The value of B chosen was 10,000. Using wave I, the following set of readings was obtained (B = 10,000 throughout):—

Volts.........	40·35	53·75	60·4	66·2	73·43	80·63	41·13	47·9	61·78
Watts	14·46	20·96	24·54	28·4	32·33	35·93	14·82	18·3	25·48
Frequency	30	40	45	50·2	55·5	60·1	30·7	35·7	46·3
Watts per period ...	0·482	0·524	0·546	0·566	0·583	0·598	0·483	0·509	0·550

If equation (1) be divided throughout by n, we get $\frac{\mathrm{L}}{n} = \eta \mathrm{B}^{1 \cdot 6} + \beta n \mathrm{B}^2$, so that for a given B the watts per period will be a linear function of the frequency if the equation is correct. When the results given above are plotted, however, it is found that the curve is not quite straight, but concave towards the axis of frequency. The author considers this effect from the theoretical point of view, and shows that it is due to the screening action of the eddy-currents in the core plates. If the plates are very thin we should expect the screening action to be negligible, and the straight-line law to hold. This the author found to be the case with plates 0·25 mm. thick for frequencies up to 60. Using the results tabulated above, and drawing a straight line through the points corresponding to frequencies of 35 and 55, and repeating the process for waves II and III, the author arrives at the following results :—

Wave.	Amplitude-factor of e.m.f. Wave.	Amplitude-factor of Magnetic Induction Wave.	η	$\beta \times 10^7$	$\beta \times 10^7 \times$ Amplitude-factor of e.m.f. Wave.
I	0·568	0·775	0·00199	5·42	3·06
II	0·707	0·707	0·00193	4·52	3·19
III	0·735	0·613	0·00186	4·19	3·07

From this it appears that both η and β decrease (for a constant value of B) as the amplitude-factor of the e.m.f. wave increases. The hysteresis loss is greater for flat-topped waves of magnetic induction than for peaked ones of the same amplitude. Further, the product of the eddy-current coefficient β and the amplitude-factor of the e.m.f. wave is approximately constant.

A. H.

710. *Transformer Design.* **H. C. Wirt.** (Journal of Electricity, S. F. 10. pp. 42–45 ; Discussion, pp. 45–47, 1900. Paper read before the Electrical Transmission Convention.)—The transformers made by the General Electric Company (N.Y.) are tested at 10,000 volts when intended for working pressures of 3,000 volts or less. The temperature rise of oil-insulated transformers should not exceed 60° C. (by resistance) after an eight-hour run at full load. Indeed a rise of 45° C. is a better limit. Higher temperatures cause appreciable increase in core loss. Out of 20,000 transformers installed during the previous eighteen months, only 10 had been returned for repairs owing to defects in the insulation. The requirements of high insulation and low temperature are more easily satisfied with the core type of transformer than with the shell type. Temperatures obtained by thermometer may in some cases be 50° C. lower than the actual temperatures, as measured by increase of resistance, especially in the shell type. Earth shields are seldom used, the secondary being earthed instead. W. H. E.

REFERENCES.

711. *Compounding Alternators.* **M. T. Gentile.** (Elettricità, Milan, 19. pp. 739–741, Nov. 24, 1900.)—The author treats the subject theoretically, making the assumptions that the current follows a sine-law, and that in actual machines the magnetic induction is sensibly proportional to the magnetising force. He arrives at an expression for the value of the exciting current, in terms of the current and e.m.f. of the alternator, and of some constants depending on its magnetic circuit and windings. G. H. B.

712. *Separation of Hysteresis and Eddy-Current Losses.* **H. Kamps.** (Elektrotechn. Zeitschr. 22. p. 111, Jan. 31, 1901.)—A letter commenting briefly on Benischke's paper (1901, Abstract No. 709) on this subject. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

713. *Power Distribution in Small Installations.* **H. A. Earle.** (Inst. Elect. Engin., Journ. 30. pp. 308–322; Discussion, pp. 322–325, Feb., 1901. Paper read before the Manchester Section of the I.E.E.)—This paper deals mainly with the relative advantages of direct and polyphase motors for small factory installations. The author gives a table showing the weight of copper required in the line on the various systems of distribution by means of direct and polyphase currents, supposing that equal power is distributed with equal loss in the line in all cases, and that the pressure at which current is supplied to lamps or motors is also the same. The advantage is almost equally divided between the three-wire direct current and the three-phase star systems. With reference to the weights of the generators, the 32-pole three-phase generators on the Central London Railway give 850 kw. at 94 r.p.m.; they weigh about 39 tons, including the exciter. On the other hand, a 10-pole direct-current traction generator, having an output of 900 kw. at 95 r.p.m., weighs 45 tons. Thus, allowing for the slight difference in output, the weights are about the same in the two cases. The polyphase machine is, however, about 10 per cent. cheaper to build, this being chiefly due to the cost of the commutator. At the same time when allowance is made for power factor, the advantage may lie with the direct-current machine. Small polyphase motors are about 5 per cent. cheaper than direct-current ones; but they are about 10 per cent. more expensive with wound rotors for sizes between 10 h.p. and 100 h.p. With regard to the operation of motors under varying conditions, the author holds that the direct-current system is the best, either from the point of view of starting torque, regulation of speed, constancy of speed, or efficiency. The power factors of polyphase motors by different makers appear to vary widely; but from the examination of a large number of cases the following may be taken as fair average values of power factors at full loads, viz.:—

B.H.P.	5	10	15	25	50	100
Power factor	0·76	0·79	0·81	0·83	0·86	0·88

Cases are finally considered where motors are required to run at variable or constant speeds with variable or constant torque, polyphase motors appearing to the best advantage under conditions of constant speed and constant torque. W. H. S.

714. *Concentric Cable Breakdowns.* **S. Hanappe.** (Écl. Électr. 25. pp. 492–502, Dec. 29, 1900.)—Referring to Kapp's important paper on this subject [see Abstract No. 755 (1900)], the author suggests some simple graphical methods of determining the maximum possible p.d. between the outer conductor and the lead sheathing of the cable. In order to take account of the iron loss, he supposes the total primary current split up into a wattless or magnetising component, and a load component. He then constructs the vector diagram for the case of a transformer whose secondary is open, and

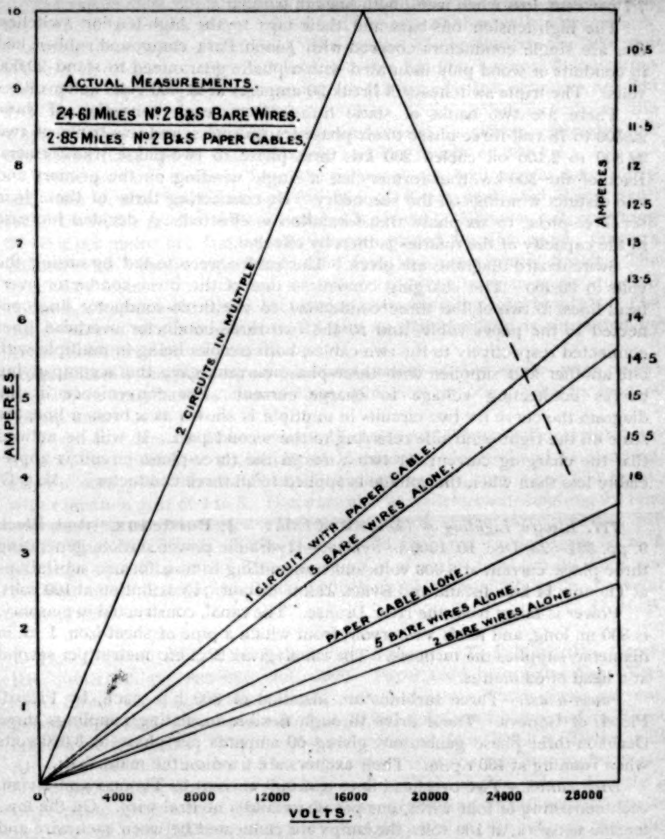
whose primary is in series with a capacity, as follows: The *ri*-component of the impressed p.d. is laid off along the vector of total primary current; the component required to balance the reactance e.m.f. is drawn so as to be in quadrature with the magnetising component of the primary current, and ahead of it as regards phase; while the component which balances the p.d. across the condenser terminals is in quadrature with the vector of total primary current, and behind it as regards phase. These three vectors when compounded give the primary p.d. vector. Since the *ri*-component is very small, it may be neglected. Using the simplified diagram, the author draws curves, showing how the condenser p.d. varies with its capacity when the primary impressed p.d. is constant. The maximum condenser p.d. is shown to be equal to $V/\sin\alpha$, where $V =$ impressed p.d., and $\alpha =$ angle of phase-difference between the total current and its magnetising component. The results so obtained are applied to the case of a concentric cable supplying a transformer, when the outer conductor is disconnected from the bus-bars before the inner [see Abstract No. 755 (1900)]. The author next applies the graphical method of treatment to the case of a transformer whose secondary is across a variable capacity, while its primary is supplied at a constant p.d. Lastly, the problem of a primary network of concentric cables is considered when there is an earth on the inner conductor. A. H.

715. *Faults on Electric Wiring.* **G. C. Allingham.** (Elect. Rev. 47. pp. 494–496, Sept. 28, 1900.)—At Guildford, the only place where a concentric system with earthed outer is in use, the outer, which is the neutral wire of a three-wire system, is protected from corrosion by being embedded in bitumen. There is danger of fire in a house from corrosion or breakage of the outer conductor. On any non-concentric metal sheathed system it is possible to blow the fuses on a faultily-wired house by daily earthing the conductors in turn at the supply station. The sheathing must, however, be continuous. Fibre-covered cables have been used in wiring new buildings without protection over the lead and without absorption of moisture by the fibre, though surface leakage is troublesome, as in all metal-sheathed systems, especially when houses are new. M. O'G.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

716. *St. Croix Power Transmission at 25,000 volts.* **H. Floy.** (Amer. Inst. Elect. Engin., Trans. 17. pp. 567–597, Nov., 1900.)—A natural fall of 30 feet was increased to 82 feet by means of a concrete dam. The minimum flow of water yields 2,000 h.p. continuously. The concrete is one part by measure of Portland cement by Alsen and Atlas, three parts sharp sand with four parts stone broken into cubes between 3½ inches and 1 inch side, and consisting of granite trap and gneiss boulders. The open hearth steel penstock is 12 feet in diameter. Four pairs of 36-inch "Victor" turbines are mounted horizontally, each pair being direct-coupled to a 750 k.w. three-phase generator, with a revolving armature separately excited, giving 800 volts and 60 cycles when running at 300 r.p.m. The water-wheel governors are an improved Giesler pattern, and allow only a 3 per cent. variation for 25 per cent. variation of lead. They are electrically controlled by the 125-volt exciter current.

The No. 2 B & S medium hard-drawn copper conductors are carried on "Provo" triple petticoat glass insulators 7 inches in diameter, mounted on locust pins boiled in paraffin. The line is level irrespective of the configurations in the earth's surface. It commences in a brick lightning arrester house abutting on the power house containing choke coils and arresters. Where an iron bridge is crossed the two parallel three-phase circuits are spiraled, in addition to which one circuit is spiraled twice relatively to the other. There are three miles of two three-conductor lead-covered cables connecting the lightning arrester house with the distributing substation; they are drawn into four-hole McRoy vitrified clay conduits in concrete. One cable is rubber and the other paper; each conductor has 66,000 circular mils; there are 7 strands, and the lead sheath is ⅛ inch thick, making the cable 2¼ inches outside diameter. The paper cable has $\frac{9}{32}$ inch insulation on each wire, $\frac{4}{32}$ inch enveloping jacket, covered by lead, which is tinned externally. The rubber cable has 35 per cent. pure Para compound, $\frac{7}{32}$ inch thick, wrapped with drilled tape round each conductor. The jacket is $\frac{5}{32}$ inch thick, and is



followed by the lead, which contains 3 per cent. of tin. The cables are tested to 40,000 volts, and are guaranteed for five years to withstand 30,000 volts. This experiment will show whether the rubber or paper under similar conditions will prove the more durable. The total resistance of each conductor from generating to distributing station is 23 ohms, the drop of volts is 3,000, and with a 90 per cent. power factor and 25,000 initial volts this gives 7·7 per cent. loss when using both lines in parallel.

The high-tension bus-bars and their taps to the high-tension switches, &c., are single conductors covered with ¼-inch Para compound rubber, laid in conduits of wood pulp indurated with asphalte guaranteed to stand 20,000 volts. The triple switches will break 50 amperes at 25,000 volts under oil.

There are two banks of static transformers, each consisting of three 22,500 to 78-volt three-phase to six-phase transformers, and two banks of two 22,500 to 2,100 oil cooled 200 kw. three-phase to two-phase transformers. Each of the 300-kw. transformers has a single winding on the primary and two distinct windings on the secondary. By connecting three of these in a set three-phase to six-phase transformation is effected. A decided increase in the capacity of the rotaries is thereby effected.

Switchboard diagrams are given. The cables were tested by raising the volts to 30,400. The charging current to one of the three-conductor overhead lines, to two of the three conductors, to the three-conductor line connected to the paper cable, and to the two three-conductor overhead lines connected respectively to the two cables, both circuits being in multiple with one another and supplied with three-phase current, gave the accompanying curves connecting voltage to charge current. For convenience in the diagram the curve for two circuits in multiple is shown as a broken line, the scale on the right-hand side referring to the second part. It will be noticed that the charging current for two wires in the three-phase circuit is appreciably less than when the voltage is applied to all three conductors. M. O'G.

717. *Electric Lighting of Thonon and Évian.* **J. Bordeaux.** (Ind. Élect. 9. pp. 521–525, Dec. 10, 1900.)—*System.*—Hydraulic power station, generating three-phase current at 3,300 volts and transmitting to transformer substations at Thonon, 14 km. distant, and Évian, 22 km. distant. Distribution at 100 volts.

Power is taken from the river Dranse. The canal, constructed in masonry, is 800 m. long, and feeds a reservoir, from which a pipe of sheet-iron, 1 m. in diameter, supplies the turbines. The canal gives 2 cubic metres per second at a head of 52 metres.

Power-house.—Three turbines are installed of 300 h.p. each, by Picard-Pietel, of Geneva. These drive through flexible insulating couplings three Oerlikon three-phase generators, giving 60 amperes per phase at 3,300 volts when running at 430 r.p.m. Their exciters are fixed on the main shaft.

Distribution.—Two overhead lines transmit current to Thonon and Évian, each consisting of four wires, one per phase and a neutral wire. On the low-tension network, at 100 volts, the lamps are connected between each wire and the neutral wire. G. H. B.

718. *Ekaterinoslaw Tramway.* **G. Orban** and **K. Winkler.** (Soc. Belge Élect., Bull. 17. pp. 461–482, Nov., 1900.)—*System.*—Overhead trolley, continuous current at 550 volts. *The boiler-house* contains four water-tube boilers by Fitzner and Gamper de Sielce ; three have a heating surface of 190 sq. m. and 44 tubes 88·5 mm. in diameter ; the fourth has a heating surface of 230 sq. m. and 131 tubes of the same diameter. The four boilers together will deliver 9,000 kilos of steam per hour as a maximum, at a pressure of 9½ atmospheres. Water is obtained from the river Dniéper, a pumping station being erected at a distance of 800 m. from the station ; the pumps are driven by two 30-h.p. electric motors. The feed-water is heated by the exhaust steam from two Worthington feed-pumps. The coal is stored in bunkers containing 320 tons, and is fired by hand.

The engine-room contains four compound engines by Tosi. These are of the vertical type with piston valves, and indicate 200 h.p. with a pressure of 8 atmospheres when running at 180 r.p.m. The cylinders are 400 and 600 mm. in diameter. The fourth engine is a tandem horizontal, indicating 350 h.p. at 8½ atmospheres, running at 110 r.p.m. ; the cylinders are 450 and 750 mm. in diameter. Four dynamos are coupled directly to the engines ; they are multipolar compound-wound machines, generating at 580 volts ; three are of 145 kw. each, and the fourth of 300 kw.

There are three tramway lines, the principal one, 6 kilometres long, being laid with double track ; except for two of 8 per cent. and 5 per cent. respectively, the gradients do not exceed 3 per cent. Vignoles rails, weighing 30 kilos per metre, are laid on oak sleepers placed 1 metre apart ; they are bonded with Chicago-type bonds, and form the only return circuit. The overhead construction is carried out, where possible, by span wires attached to the houses, and elsewhere by wooden poles carrying iron brackets. The trolley wire is of silicium-bronze, 8·3 mm. in diameter, and is supported by Aetna insulators and mechanical ears.

The line is supplied by two feeders carried on the trolley-wire poles ; one, 250 m. long, has a section of 53 sq. mm., and the other, 3,000 m. long, of 265 sq. mm.

The motor cars are 26 in number, 17 closed and 9 open ; they weigh complete 7·5 tons, and have a capacity of 16 passengers seated and 14 standing. Each is equipped with two 30-h.p. Schuckert motors, running at 550 r.p.m., with reduction gear of 1 to 5. There are also 25 trailers, each weighing 2·3 tons and carrying 36 passengers. The normal speed of the cars is 12 kw. per hour. Each car travels on the average 160 km., and carries from 5½ to 6 passengers per kilometre. The consumption of coal is from 2·2–2·4 kilos per car-kilometre. The paper includes a diagram of the switchboard and several photographic views. G. H. B.

719. *Rochester and Sodus Bay Electric Railway.* **T. J. Nicholl.** (Street Rly. Journ. 16. pp. 883–885, Oct., 1900. Paper read before the New York State Street Rly. Association, Sept., 1900.)—*System :* Three-phase current, generated at 380 volts, transmitted at 10,000 volts, and converted to direct current at 600 volts. The *boiler-room* contains four 250-h.p. Taylor and Altman water-tube boilers. The *engine-room* contains two horizontal cross-compound Corliss engines, of 500 h.p. each. Each engine drives directly a three-phase generator of 300 kw. capacity, generating at 380 volts, 25 cycles per second. Six 100-kw. stationary transformers in the station raise the pressure to 10,000 volts for transmission to two substations. There is also a rotary converter in the station, receiving alternating current at 380 volts and feeding the western section of the railway with direct current at 600 volts. The transmission line consists of three No. 1 bare copper wires 18 inches apart, at the corners of an equilateral triangle. The substations are 12 and 24 miles from the generating station ; each contains three step-down transformers and one 250-kw. rotary converter. Distributors of No. 0000 gauge run three miles each way from the converters ; the trolley wires are divided into six

sections, joined by circuit-breakers. The station is equipped with high-pressure oil-break switch-gear and special time-limit circuit-breakers. The track is equipped on the overhead trolley system. Wooden poles, 30 to 40 feet long, and spaced about 110 feet apart, carry, by means of bracket arms, two No. 00 figure-8 copper wires. The high-pressure line runs across country away from the railway, and is also carried on wooden poles, with porcelain insulators. The rails are of both T and girder type, 60 lbs. per yard, tied together by wooden ties. The fishplates are 24 inches long, with 4 bolts, and the joints are bonded with a No. 0000 copper bond 8 inches long. The foundation of the track is local ballast and gravel. The track is single, 39 miles long; a length of 13 miles runs over private right-of-way. The heaviest gradient is 5 per cent., and the sharpest curve has a radius of 100 feet. A turnout is provided in every mile of track. There are 18 passenger and combination cars, 45 feet long, each fitted with four G.E. 57 or G.E. 1,000 motors, and carried on Taylor radial trucks, as well as four 26-feet motor cars and six 26-feet trailers.

The capital outlay was about £144,400, as follows: Track, line, right-of-way, &c., £90,600; machinery and buildings, £26,800; car equipment, £23,000; organisation expenses, £4,000. One train is run each way every hour from 6 a.m. to 9 p.m. The line is divided into 13 fare limits of 2½d. each. The full distance is covered in 2 hours 50 minutes, including 50 stops. A. H. A.

720. *Electric Equipment of the Wansee Railway, Berlin.* **R. Rinkel.** (Zeitschr. Vereines Deutsch. Ing. 44. pp. 1198–1209, 1900.)—A description is given of the third-rail railway equipment which was carried out by Siemens and Halske between Berlin Wansee station and Zehlendorf station. The motors, of which there are three to each motor car, are mounted direct on the axles, the top and bottom poles being consequent so as to get the necessary clearance between the bottom of the motor and the road-bed. The conductor rail is fixed some distance above the track rail and is insulated by a

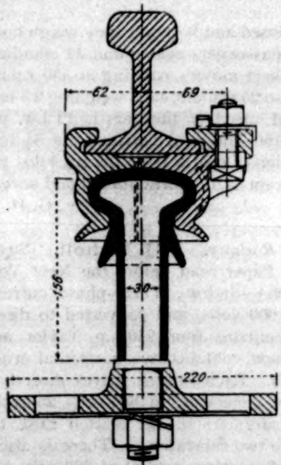


FIG. 1.

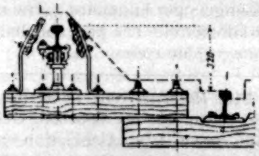


FIG. 2.

hard rubber composition as shown in Fig. 1. The conductor-rail is protected by boards carried along each side as shown in Fig. 2. The dynamo gives 450 amperes at 718 volts, and there is a large battery at each end of the line.

E. K. S.

721. *Electric Lighting of the SS. "Deutschland."* (Engineering, 70. pp. 723-724, Dec. 7, 1900.)—The generating plant consists of three steam-dynamos of 700 amperes each, and two of 400 amperes each, at 110 volts, running at 250 r.p.m. The engines are of the vertical compound type, direct coupled to the dynamos. There are 1,500 25-c.p. lamps, and 1,550 16-c.p. lamps, 70 connections for small ventilators, and 375 for curling-irons. The power circuits supply 23 motors of 50 h.p. in all, 8 stoves, and some small apparatus. There are three main circuits—for "police" lighting, including all the lamps essential to safety, general lighting, and power. Provision is made for connecting any circuit with any dynamo. The conductors are insulated with vulcanised rubber. Indicators in the steering-house show whether the signal lamps are alight or not. The installation was carried out by the *A. E. G.* Diagrams of the switchboard and light and power circuits are given. A. H. A.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

722. *Recording the Tractive Force and Acceleration of Trains.* **A. Mallock.** (Engineer, 90. p. 323, Sept. 28, 1900. British Assoc. Report (1900), pp. 877-878.)—The author uses a short pendulum whose free vibrations are adequately damped which hangs in a direction due to the resultant of gravity and the acceleration which the bob at the time experiences: hence the angle which the pendulum makes with the vertical is a measure of the acceleration at each instant. On a frictionless train moving under gravity along any series of gradients the pendulum will always hang normal to the line. The angle which the pendulum makes with a fixed direction of the carriage gives a measure of the horizontal force acting on the carriage independently of gravity and is equal to the motor tractive force, or the resistance. It is noted that when going round a curve, if each carriage supplies its own motive force at the expense of its kinetic energy, the whole of the sideways force which is required to keep the train on the curve is supplied by the pressure of the rails on the wheel flanges. If the motive force is transmitted from a motor at one end of the train the angle which each carriage makes with the one behind it gives rise to a couple which lessens the pressure between the rail and flange.

A curve is given showing the record of a steam locomotive starting a 100-ton train; also of direct-acting electric motors working on a 180-ton train, the application of brakes, and the gradual bringing to rest of the train by the effect of resistance. M. O'G.

723. *Measurement of Tractive Force on Tramways.* **G. Kapp.** (Elektrotechn. Zeitschr. 21. pp. 579-580, 1900. Paper read before the 8th Jahresversammlung des Verbandes Deutscher Elektrotechniker in Kiel.)—The author proposes a method of measuring the tractive force exerted on a car, by a manometer consisting of a long tube, fixed horizontally in the car, and bent vertically upwards at each end. This, if filled with liquid, will show on a vertical scale the tangent of the angle of inclination of the car, which, neglecting the difference between the sine and the tangent of the small angle, is a measure of the tractive force due to the gradient,

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Again, an acceleration of the car will produce a difference of level in the two liquid columns, proportional to p/g, where p is the acceleration of the car. The author gives calculations showing that the difference in level of the liquid columns is proportional to the total tractive force due to gradient and to acceleration, within a maximum error of 1 per cent.; he points out, however, a possible source of error due to unequal loading of the car-springs, which may give the car-body an inclination relatively to the rails. The tractive force due to rolling and other friction may be determined by a measurement made on a level track, while the car is slowing down, without applying brakes.

The author employs a tube 50 cm. long filled with mercury, with an indicator tube of 5 mm. bore filled with water; with this, readings can easily be made to within ½ kg. per ton. The results are given of some measurements made by the author with this instrument on the Berlin tramways and the Lichterfeld railway. G. H. B.

724. *Permanent Way for Electric Traction.* **H. R. Hooper.** (Tram. Rly. World, 9. pp. 586–589, Dec., 1900.)—Generally speaking, permanent way costs £6,000 per mile of single track, or, roughly, about one-third of the total capital expenditure on an electric tramway. Its life is much shorter than that of any other branch of traction work and may be generously taken at an average of ten years. This means that every year £520 per mile of single track must be earned over and above all fixed charges and maintenance to form a sinking fund at 3 per cent. for permanent way alone. Once let the permanent way get into a bad state and the general repairs on rolling stock and the coal bill rise together in alarming proportions. On a steam railway the rails supported on sleepers act as girders and yield under the live loads, but with electric traction the rails are supported evenly throughout their length, and tensible strength is of little consideration and hardness becomes the dominant factor. The lowest tender for rails is by no means the cheapest, for an increase of 10s. per ton on a mile of single track with 90-lb. rails means only £70, whereas if the better rail increases the life of the permanent way for one single year a saving of £520 is effected. At the present time rails can be obtained of about the following chemical analysis: Carbon 0·45 to 0·55 per cent., silicon 0·06 to 0·08 per cent., phosphorus 0·06 to 0·08 per cent., sulphur 0·05 to 0·06 per cent., manganese 0·80 to 1·00 per cent., and this composition gives a fairly good rail, but efforts should be made to produce greater hardness. The usual chilled cast-iron wheels rapidly wear out the rails, and owing to the narrowness of the groove in this country, the life of such wheels is only one-third of what it is in America. It is therefore possible that in this country the more expensive tyred wheels would be economical.

Fishplates should be 24 to 30 inches long, and have six or eight 1-inch steel bolts, which should be checked with a cold sett after the fishplates have been screwed on as tightly as possible. Cement, mortar, or pitch is only effective for a few years in preventing the nuts from turning. Sole plates under joints are not to be commended. Rails should be laid with butt joints, for in paved work they do not creep from contraction or expansion. One of the secrets of getting a good permanent way is to have the rails delivered on the site perfectly straight and true. This is more possible with 45-feet rails than with 60-feet rails. For a sett 5 inches deep, the rail should be 6½ inches high so that the concrete can be brought over the bottom flange to seal the packing under the rail, and hold it to gauge. Tie-bars should be of wrought iron 2 inches by ⅜ inch.

Concrete is usually 6 to 1, but if laid in ordinarily fine weather, 7 to 1 is ample. Setts should be fitted as closely as possible against the rails, and joints should not exceed ¾ inch; a pitch grout to within ¼-inch of the top forms the best joint, as it prevents surface water soaking through to the bed of concrete. Experience shows that Jarrah wood blocks, though exceedingly hard, require more care in laying and subsequent watching than softer woods, and their expansion is quite sufficient to affect the gauge. The question of using inserted manganese steel plates on the wearing parts of points and crossings deserves attention. The angle at points and crossings should not exceed a maximum of 1 in 8, but if too easy, the taper becomes too long. E. H. C.-H.

725. *Surface Contact System of the Helios Company.* **J. P. Doflein.** (Elektrotechn. Zeitschr. 21. pp. 924–926, Nov. 8, 1900.)—Description of a surface contact system which is under trial by the Helios Elektricitäts A. G. Two studs are placed side by side at intervals, and six of these pairs of studs are connected to a circular box by the side of the track. This box is neatly designed, and contains the solenoids which make and break connection as the car moves over the studs. E. K. S.

726. *Electric Automobiles.* **R. A. Fliess.** (Elect. World and Engineer, 36. pp. 516–523, Oct. 6; 563–566, Oct. 13; 599–605, Oct. 20; and 635–638, Oct. 27, 1900.)—Tests were carried out on ten vehicles of six different makes. A 31·5 mile run on one charge in a crowded street with two passengers gave the following results :—

Weight of vehicle	3,085 lbs.
Weight of passengers and instruments	305 „
Weight of load carried	nil.
Total weight	3,390 lbs.
Battery equipment	44 cells
Weight of battery	1,120 lbs.
Ratio of battery weight to total weight of vehicle	36·3 per cent.
Ratio of battery weight to total weight causing draw-bar pull	33 „
Total distance covered during test	31·51 miles
Total time in motion during test	3 hr. 23 m. 35 sec.
Average speed while in motion	9·28 miles per hour
Average watt-hours used [on car] per car mile	155·27
Average watt-hours used [on car] per ton mile	91·6
Total watt-hours used on trip	4,892·8

It was found that 90 watt-hours per ton mile was a fair average, but this could be reduced to 80 watt-hours per ton mile by the use of ball bearings, the vehicles having solid rubber tyres. On adding a load to two vehicles, it was found that the watt-hours per ton mile remained the same for each. The author favours for commercial purposes the lightest vehicle that can be used. Pneumatic tyres show a slight increase of power consumption over solid tyres. The tests were taken for the most part over good asphalte in ideal weather. Over macadam the power consumption went up to 116 watt-hours per ton mile. In heavy rain, wind, and in five inches of snow and slush the average power was 114 [*sic*] watt-hours per ton mile, under "the most trying conditions a car will ever be called upon to contest."

A pleasure vehicle was tested as follows :—

Weight of vehicle	1,165 lbs.
Weight of passengers and instruments	305 ,,
Total weight	1,470 lbs.
For a distance of	3·31 miles
Average speed while in motion	9·68 miles per hour
Average watt-hours used per car mile	63·32
Average watt-hours used per ton mile	86·14
For a distance of	2·35 miles
Average speed while in motion	6·79 miles per hour
Average watt-hours used per car mile	73·53
Average watt-hours used per ton mile	100·04

The battery efficiency when in good order was found to be 68 per cent. Twelve tests on four carriages over the same ground are summarised below :—

Distance covered in miles.	Speed in miles per hour.	Watt-hours used.	Watt-hours per car-mile.	Watt-hours per ton-mile.	Weight causing Draw-bar pull.	Time in motion. Min.
2·62	10·14	404·4	188·7	83·11	4525	15·5
2·67	10·68	489·6	183·37	81·02	4525	15
2·57	9·44	414·4	161·24	80·31	4015	16·25
2·61	11·18	396·8	152·03	81·87	3714	14
2·64	11·31	342·4	129·69	69·83	3714	14
2·63	10·52	336	127·75	68·79	3714	15
2·52	10·8	356·8	141·58	83·52	3390	14
2·54	9·83	353·6	139·22	82·13	3390	15·5
2·55	10·31	339·2	133·02	78·41	3390	14·8
2·55	10·93	328	128·62	75·88	3390	14
2·56	10·24	384	150	89·42	3355	15
3·31	9·68	209·6	63·32	86·14	1470	20·5

The author concludes that 22 miles on one charge at an average speed of 8·5 miles per hour in crowded streets, with a maximum consumption of 115 watt-hours per ton mile with an average battery efficiency of 70 per cent., may be obtained if the running voltage is not allowed to drop below 1·75 volts per cell.

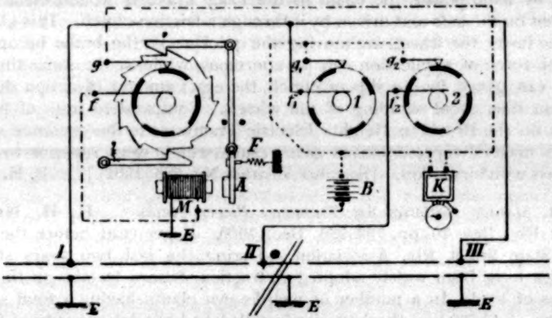
From a large number of observations in Manhattan, delivery vans are in motion less than 25 per cent. of the elapsed time, the average speed being 7 miles an hour. From elaborate investigation the longest distance covered by a two-horse van was 21 miles, the time being 8 hours 10 minutes, but the average speed was 2·82 miles per hour.

On the average, taking 16 miles as the distance travelled, 50 lbs. as the pull exerted, and 7 miles per hour as the speed while in motion, a horse does 4,356,000 foot-lbs. of work a day. As a final comparison the author makes a saving of 25 per cent. in favour of the automobile, but when allowing for depreciation, 25 per cent. is shown in favour of the horse when an electric vehicle and a horse are required to do the same amount of work.

When, however, the advantage of the greater speed allows the electric vehicle to do its maximum work per day, the economy in favour of the horse is reduced to 1 per cent. M. O'G.

727. *Electric Delivery Van Equipment in New York.* **M. Loewenthal.** (Elect. World and Engineer, 36. pp. 987–990, Dec. 29, 1900.)—A description of the various electric vans made for, and in use by, a large dry goods establishment during the past three years. The latest form is a truck which is 14 feet long, weighs 6,000 lbs., is fitted with 44 cells having 160 ampere-hours capacity, and is propelled by two 2-h.p. Westinghouse motors. This truck makes a six-mile journey twice a day, and is capable of running 20–30 miles on one charge ; it is designed to run at a speed of 7 to 8 miles an hour, and to carry four persons in addition to a load of 2 tons. Full particulars of the special charging facilities, which have been provided, are given, and the author states that this equipment has already proved electric vehicles of this kind to be a commercial success, provided that they are properly handled and cared for. Illustrations of the vehicles and of the charging plant and "stable" accompany the article. A. G. N.

728. *An Improved Form of Langbein's Train-Signalling Apparatus.* **F. Blacizek.** (Zeitschr. Elektrotechn., Wien, 18. pp. 622–623, Dec. 23, 1900.)—This improvement on Langbein's system of signalling (see Zeitschr. Elektrotechn., Wien, 13. pp. 641–645, 1895), renders it capable of working, although somewhat imperfectly, even if one or more of the fixed contacts on the permanent way fail, the failure making itself known by the continued ringing of the bell, thus enabling the attendant at the station to readjust the apparatus. The system is shown diagrammatically in the accompanying diagram, with the apparatus in its normal position.



On the train reaching I, the circuit of the electromagnet of the feed-mechanism is momentarily completed at f_1, g_1, and the contact discs turned through an angle corresponding to one tooth, whereupon the bell circuit is completed at *g*, *f*. On the train reaching II, the discs are again turned through an angle corresponding to one tooth, and the bell-circuit interrupted. On the train reaching III, the discs are again turned, so as to restore the initial conditions ready to commence a fresh cycle, one revolution corresponding to four cycles. It will be seen that if the connection is not made at I, the bell will not ring till III is reached, when it will remain ringing. If II fails, it will also continue to ring, since III acts similarly to I. If III fails, the fault will not appear until the passage of the next train, after which the bell will continue ringing. C. K. F.

729. *Electrically-Controlled Bolt-Lock for Railway Points.* **J. Schnatter.** (Zeitschr. Elektrotechn., Wien, 18. pp. 601–604, Dec. 9, 1900.)—In this arrangement a bar, which is connected by a link to the switch or sliding rails, passes through a cast-iron box, and is provided in this box with three recesses. Two of these recesses lie, in each of the positions of the bar, opposite to two hinged bolts moving in opposite directions and provided with weighted levers which normally hold the bolts out of engagement with the recesses. These weighted levers are connected to a vertically sliding rod in such a manner that the bar is locked on raising the rod by hand. The sliding rod is held in its raised position by a detent engaging with the upper one of two pawls mounted respectively on the arms of a pivoted ∩-shaped lever bearing a polarised armature. This armature is arranged near the poles of an electromagnet, so that, by sending an alternate current through the electromagnet, the pawls will be oscillated and the rod allowed to fall, thus permitting the weighted arms to unlock the bar. Three pairs of contacts are also provided which are completed respectively when the rod is in its raised position, *i.e.*, when the bar is locked, and when the bar is in each end position; these contacts enable the positions of the parts to be determined from the signal-box at any time. The original paper is illustrated by drawings and diagrams.
C. K. F.

730. *Price's Friction Car Brake.* (Electrician, 46. pp. 318–320, Dec. 21, 1900.)—Instead of the brake-levers being applied by a chain wound on a barrel by hand-power, the chain in the Price brake is wound on a barrel mounted on the axle and driven by it through a friction-clutch. It is claimed that the faster the wheels are moving the quicker can the brake be applied, and the force of application can be enormous, while at the same time the driver can gauge, by the slip of clutch, the exact amount of action desired, and can thus avoid skidding of the wheels. Comparative tests of power-brakes on the Brooklyn Heights Electric Tramways in the presence of the various makers' representatives gave results which were superior to those obtained with air-brakes. [See also Abstract No. 586 (1901).] E. H. C.-H.

731. *Storage Batteries for Tramway Power Stations.* **H. H. Norris.** (Street Rly. Rev. 10. pp. 733–736, Dec., 1900. Paper read before the New York State Street Rly. Association.)—During the last two years storage batteries have been widely adopted in traction stations to take up the fluctuations of load. In a number of well-known plants, having a total station capacity of 48,560 kw., the batteries installed had a total capacity of 28,560 amperes for one hour, or an average capacity of ⅗ ampere-hour per kw. output at the discharge rate mentioned. From the daily records of the Buffalo Railway Company's plant for the month of March, 1900, it was found that in 31 days the battery received 189,369 ampere-hours, and gave out 164,036 ampere-hours, which is an efficiency of 86·6 per cent. as to ampere-hours. The same plant was elaborately tested by the Sibley College students [see Abstract No. 294 (1901)], and the results showed that more steam and more coal are consumed per i.h.p. when the battery is not in operation than when it is.
E. H. C.-H.

732. *Protection of Telegraph and Telephone Lines against High Potential Currents.* **Piérard.** (Soc. Belge Élect., Bull. 17. pp. 279–286; Discussion, pp. 286–294, 1900.)—The Belgian Government prescribes that, where practicable, there shall be three guard wires—one in the vertical plane of the trolley wire, the others disposed on either side and in the same horizontal plane as the first; that these wires shall be attached to insulators, but connected to earth at every post or alternate post. If the telegraph or telephone wires above happen to be parallel to the trolley wire there must be, in addition, transverse guard wires. In the discussion it was stated that practice had shown that an earth connection at the fourth or fifth post was sufficient. But the protective wood lath, or sheath is also in use in Belgium, and is discountenanced by the author as being insufficient and dangerous. Numerous accidents to persons, and to telephones and switchboards, had been caused, and the trolley derailed by this appliance. The lengths of wood are apt to separate at their junctions, the attachments to become loose, and, in damp weather, the wood, even when impregnated before erection, is not a sufficiently good insulator to protect a fallen wire from diverting current. In Brussels a test gave absolute insulation of only 4,500 ohms in damp weather, and in heavy rain the leakage effect would be marked. It is found that a current of only $\frac{1}{8}$ ampere, not enough to melt the fuses, if flowing for some hours, will carbonise the bobbins of telephone bells. Then, again, bronze wire retains spring long after it is erected, and having originally been coiled on small drums, curls up in a spiral when broken, and is thus apt to get round the protector into contact with the naked part of the trolley conductor. These considerations bring the author to favour guard wires. By connecting these to earth a telephone wire which falls across a guard and the trolley wire will become melted by the current, and the end will fall clear. Against the use of guard wires is the additional strain thrown upon the posts, especially upon curves, and, upon existing lines of tramways, the means and appliances for the necessary attachments must be provided. Further, when the trolley wire is accidentally earthed by a slack guard wire, or by coming into contact by flexure, the automatic cut-outs at the central station will cut off the current and arrest the system. To these objections the author replies that the guard wires must be at least 60 cm. above the trolley wire, and that the guards need be only copper wires 8 mm. in diameter. In the discussion the use of guard rings and ramps of metal for telephone and telegraph wires was suggested. These are earthed, and a broken conductor will fall against one or the other and earth itself, and should it also come into contact with a feeder or a trolley wire the apparatus is protected from damage, and the cut-out will come into operation at the central station.

But switchboards at exchanges and subscribers' instruments must also be specially protected from these accidental contacts as well as from lightning. For the former in Belgium, point and paper dischargers are installed near the entry of the lines, and on the same board and consecutive to the dischargers are two platinum wire fuses in glass tubes held in metallic clips; the wire is 5 cm. long and 0·05 mm. in diameter, and fuses after a few seconds when subjected to a current of 0·9 ampere; the annunciator bobbins will support this current for some minutes. In Brussels, however, the fuses are arranged to go with 0·5 to 0·6 ampere. The metal caps at the ends of the tubes are pierced, so that when the fuses are blown the heated air can escape. Similar fuses are employed in the exchanges, but here they are in groups, and are sunk in holes in a board. At the bottom of such a hole is a small metallic cap and spiral spring; the interior cap of the fuse tube presses against this, and a screw plug closes the entrance of the hole, bearing inwardly against the other cap of the tube; the latter is thus imbedded and safe from accidental fracture. A wire passes through the board to the back cap and ends outwardly in an eyelet, and the screw plug socket has a small projection; to these the line and switchboard wires are soldered after leaving the lightning dischargers.

E. O. W.

733. *Trolley-Wire Guards.* **Piérard.** (Assoc. Ing. Él. Liège, Bull. 11. pp. 171–178, Aug. 14, 1900. An addendum to the paper referred to in the preceding Abstract.)—The author controverts the arguments of Pedriali and d'Hoop referred to in Abstract No. 945 (1900), that wooden guards fixed to trolley wires are sufficient protection against dangers from overhead telegraph and telephone wires. Piérard cites several bad accidents caused by the broken wire getting into contact with the metal sleeves fixing the guards, or twisting round the trolley wire when falling, or touching the trolley itself; or else by being dragged along by street traffic and being drawn on to the trolley wire at a defective point in the wooden guards. He also quotes a case in Brussels where the insulation of the wooden guard proved to be only 4,500 ohms. He thinks such a protection quite insufficient. He advocates guard wires vertically above the trolley wires, sufficiently high to obviate possible contact with the trolley, should it leave its own wire. The guard wires should be on insulators at the posts, and put to earth at intervals by the rails with insulated wire. These guard wires need be only light ones, say bronze of 3 mm., or iron of 4 mm. in diameter. E. O. W.

734. *Taylor's Interlocking Electric Switch and Signal System.* **J. R. Cravath.** (Elect. World and Engineer, 36. pp. 404–407, Sept. 15, 1900.)—Two methods hitherto in use for operating interlocking switch and signal plants from a central tower are the manual by rods, chains, wires, and levers, and the electro-pneumatic. In the former there are difficulties by friction and slack, as well as from snow and ice in winter; and in the latter from expense, the presence of moisture in pipes and packings in cold weather, and from the fact that a compressor plant must be kept constantly running to supply waste by leaks. Taylor's system is adopted at the Path Street Depôt in Chicago as well as on other roads. The switches are worked by electric motors geared to a mechanism connected directly to the switch-rods. The only connections between the tower and the switch are the two wires comprising the motor circuit. There is thus better protection from the weather than in the manual or pneumatic systems. It has, moreover, surplus power to overcome snow and ice round the switches. The semaphores and dwarf signals are also worked respectively by motors and solenoids. The source of power is a 60-volt storage battery, charged by a gasoline engine of 2 h.p., with a 1-kw. dynamo. It is found that the electric installation is cheaper in first cost than either of the others, and, of course, economical to operate. Motors at the switches are of 1 h.p., taking usually about 7 amperes at 60 volts, one movement occupying two seconds. In opening a switch the motor, connected to appropriate toothed gear and rods, makes one complete revolution, when the armature connections are automatically reversed. This cuts off current also, establishes a new circuit for again closing the switch when required, and temporarily causes the motor to act as a generator and send back current momentarily to the signal tower to enable the signalman's lever or handle to come "home" in his interlocking machine, and thus affords him indication of the proper working of the distant switch. In connection with the latter an indicator is used on all facing points, so that in case a point is not fully closed, the signals governing the approach to the switch cannot be set to clear. For the dwarf signals the operative solenoid has two windings, the low resistance one being that which pulls up the arm against gravity. Near the end of the movement the high resistance is automatically switched in, and the current thus reduced from 6 amperes to ¼ ampere, which suffices for "holding up." For the semaphore arm the

current is in like manner reduced for "lifting" and "holding up" from 2 amperes for the motor to $\frac{1}{10}$ ampere for a magnetic clutch. When the signalman pulls a handle to throw a switch he cannot at first throw it the full length of its stroke. As soon as the handle has gone far enough to throw the motor circuit, it is caught, and cannot be shoved home to unlock the handle that will give the clear signal until the current from the switch motor acting as a dynamo at the end of its stroke energises certain magnets and releases a bar. The switch must therefore be positively opened or closed before any movement corresponding to it can be completed in the interlocking tower. E. O. W.

ELECTRIC LAMPS AND LIGHTING.

735. *Alternating Current Enclosed Arc Lamps.* **H. W. Hillman.** (Journal of Electricity, S. F. 10. pp. 27–36; Discussion, pp. 36–39, and p. 42, Aug., 1900. Paper read before the Electrical Transmission Convention.)—The author compares arc lamps of this type with direct-current open arcs for street lighting, and gives some particulars of instances in which the former have been adopted. The high efficiency, economy of space, and good regulation of constant-current transformers are emphasised, and the conditions of installing and working the system are dealt with. In the discussion the use of flat carbons, 5 inches wide × ¼ inch thick, for 700 direct-current arc lamps in Philadelphia was said to be successful; one trimmer suffices for the whole of the lamps. The inefficiency of direct-current series arc light machines was pointed out, and divergent views expressed on the question of direct *versus* alternating current. A. H. A.

736. *Street Lighting.* **E. C. Jones.** (Journal of Electricity, S. F. 10. pp. 115–117, Dec., 1900. Paper read before the third annual Convention of California Municipalities, S.F., Dec. 14, 1900.)—The lighting of the streets of San Francisco by Welsbach lights is described. The lights are of 100 c.p., placed in boulevard lanterns with opal tops. They are fixed 160 feet apart along the line of the street, or, measured diagonally across the street, 180 feet. The posts have one, two, or three complete burners. A comparison is made between this method and electric lighting. The area of the mantle per c.p. being much greater than the area of the glow-lamp filament or arc-crater per c.p., a much better distribution of light is obtained. A considerable advantage is also claimed for the Welsbach in the fact that the composition of its light makes it far more penetrating through a foggy atmosphere than the arc light. The statement is made that the incandescent gas is rapidly and permanently displacing all other methods of street lighting. The present cost of street lights in San Francisco is given as follows:—

	Candle hours for 1 cent.
Ordinary gas lights	22
Arc lights	85·7
Welsbach	111

The paper concludes with a table showing the number of inhabitants of some of the large cities of the United States per 100 c.p. of street illumination. San Francisco, with 40 inhabitants per 100 c.p., comes out the best. For New York and Brooklyn the number is 86. W. W. H. G.

TELEGRAPHY AND TELEPHONY.

737. *Poulsen's Telephonograph.* **Rellstab.** (Elektrotechn. Zeitschr. 22. pp. 57–59, Jan. 17, 1901.)—In this paper there is given, in addition to a short description of the apparatus [for full description see Abstract No. 1973 (1900)], a mathematical discussion of the physical processes involved. Expressions are found for the current in the electromagnets making the record in the steel wire, the permanent magnetisation of the wire, and the current in the telephone receiver, together with the condition for obtaining correct reproduction of the tones of the human voice. C. K. F.

738. *Wireless Telegraphy.* **E. Guarini** and **F. Poncelet.** (Comptes Rendus, 131. pp. 540–541, Sept. 24, 1900.)—Electric waves generated by the sparks between the knobs of a Wimshurst Hertz machine may be divided into three kinds. The first strike the coherer directly, the second meet it after reflection, and the third have no effect. A screen will cut off the first, and the human body, even when carefully insulated from the ground, acts in this way. But a thin sheet of iron does not effect screening unless it is connected to the earth. The authors conclude that the sheet of iron becomes a fresh source of radiation acting by the induction of one of its faces on the other. Hertz waves would therefore appear to be susceptible of induction, a fact which is utilised in the Guarini repeater. M. O'G.

739. *Simple Wireless Telegraph Receiver.* **A. Trowbridge.** (Nature, 63. pp. 156–157, Dec. 13, 1900.)—The relay tongue and contact act as coherer, closing the circuit of the relay electromagnet, which produces immediate decoherence by drawing the tongue away from the contact. A telephone with condenser in series is placed as a shunt on the coherer circuit. A "dot" is heard as a single tick and a dash as a series of ticks. J. E.-M.

740. *Synchronous Impulse System of Multiplex Wire, or Wireless, Telegraphy.* **A. Bull.** (Elektrotechn. Zeitschr. 22. pp. 109–111; Discussion, p. 111, Jan. 31, 1901. Paper read before the Elektrotechn. Vereins, Dec. 18, 1900.)—This method depends on the employment of a number of different series of impulses. Each series consists of a given number of very short but perfectly similar impulses, which follow one another at definite but unequal intervals. It is by proper choice of these intervals that the various series are differentiated. Each corresponding pair of stations is so arranged that the sender can only send one type of series, and the receiver only responds to the same type. As was pointed out by Dr. Strecker in the discussion, this method is of little use, as each signal requires a number of impulses to be sent, while one impulse is sufficient for each letter if Hughes' printing telegraph be used. Hence it would be at least as rapid to send the messages consecutively to the various stations as to employ this method to send them simultaneously. J. E.-M.

REFERENCE.

741. *Telephonic Receiver for Wireless Telegraph Signals.* **Popoff** and **Ducretet.** (Comptes Rendus, 131. pp. 1296–1298, Dec. 31, 1900.)—A receiver practically identical with that used by Hughes in 1879. See Fahie's "History of Wireless Telegraphy," Appendix D. J. E.-M.